Deloro Mine Site Cleanup
Tailings Area Closure Plan
Final Report

Prepared for:

ONTARIO MINISTRY OF THE ENVIRONMENT

Prepared by:

CH2MHILL

Responsible Solutions for a Sustainable Future®

August 2004

Executive Summary

The Deloro Mine/Refinery Site, located in Eastern Ontario, began operation as a gold mine in the 1860s. Over the next 100 years, site activities also included the smelting and refining of a number of other elements including arsenic, silver, and cobalt. Activities associated with the mining, smelting, and refining of metals ceased in the 1950s. These historical activities at the site have resulted in significant environmental impacts to the soil, groundwater, surface water, and sediment quality both onsite and offsite.

Abandonment of the site by its owner(s) forced the Ontario Ministry of the Environment (MOE) to take control of the property in 1979 and to initiate control measures to limit the environmental impact from the site. Remedial initiatives by the MOE have resulted in reductions of arsenic loadings to the Moira River. Arsenic loading to the Moira River has been reduced by more than 80 percent from an annual average of 52.1 kg/day in 1979 to an annual average of less than 10 kg/day since 1983.

To provide further treatment, and to mitigate any unacceptable impacts on human health and the environment, CH2M HILL Canada Limited (CH2M HILL, formerly CH2M Gore & Storrie Limited [CG&S]) was retained by the MOE to develop and implement a comprehensive rehabilitation program focusing on four individual areas of concern at the Deloro Mine Site. These areas included the Mine Area, the Industrial Area, the Tailings Area, and the Young's Creek Area. Subsequently, a detailed evaluation of rehabilitation alternatives was conducted by CH2M HILL in 2002/2003 separately for each of these four areas, which resulted in a rehabilitation alternative being recommended for each area of the site. CH2M HILL then further developed the recommended rehabilitation alternative by completing a separate Closure Plan for each area of the site. This report serves as the Closure Plan for the Tailings Area of the site.

From 1914 to 1960, the Tailings Area was used to dispose of the by-products of the hydrometallurgical process employed at the site. The main component of the tailings is ferric hydroxide (red mud). However, because selective precipitators used in the refining process did not typically offer a high degree of metal separation, metals such as copper, cobalt, nickel, trace heavy metals, and arsenic are also found in the tailings. It is estimated that 90,000 tonnes of dry red mud have been impounded in the Tailings Area.

Previous investigations have indicated that contaminants are released from the Tailings Area by two processes: through leachate movement and by physical transport of fines. Groundwater and pore water sampling in the Tailings Area have shown that contaminants in seepage include arsenic, cobalt, copper, nickel, zinc, cadmium, molybdenum, and silver. The Tailings Area is the single largest source of cobalt contamination on the Deloro Mine Site property and accounts for approximately 71 percent of the total sitewide cobalt loading to the Moira River and Young's Creek. The underlying rationale for remediating this area of the Deloro Mine Site is that by reducing this source of cobalt loading, it is likely that all other less significant metal loads will be similarly reduced.

A detailed evaluation of remediation alternatives resulted in the following comprehensive remediation alternative being recommended for the Tailings Area:

- Cover the surface of the Tailings Area with soil and vegetation, divert surface runoff away from the Tailings Area and collect and treat contaminated seepage and groundwater from the Tailings Area (In this option, collected seepage and groundwater are directed to the existing onsite arsenic treatment plant [ATP].)

The recommended remediation alternative was based on reducing water contact and infiltration through the surface of the Tailings Area, treatment of contaminated seepage and groundwater during the vegetation establishment period and after, as required, and reducing the amount of surface run-on from the surrounding environment. Seepage production is predicted to be reduced sufficiently that the seepage contribution will be negligible, or that seepage volume and contaminant loading will be reduced such that a natural treatment system can be installed to provide long-term passive water quality improvement.

The recommended remediation alternative consists of:

- A soil cover consisting of a layer of silty clay loam in combination with topsoil, sand and compacted clay materials. The topsoil provides the initial rooting medium for the vegetative cover (poplar trees and grasses), while the silty clay loam and sand provide the necessary water storage capacity that will increase the effectiveness of the poplar trees. The compacted clay layer functions as a low-permeability layer to minimize percolation of water into the underlying limestone cover and tailings (red mud). Based on the findings of the feasibility study (CH2M HILL, May 2002), the construction of a soil cover incorporating a 100-cm silty clay loam layer in addition to a 15-cm topsoil layer, a 30-cm sand drainage layer containing HDPE perforated pipe, and a 30-cm compacted clay base is predicted to be sufficient to achieve deep percolation reductions of 83 percent below existing conditions. An irrigation system will be installed and operated for a period of approximately three years, during the maturation of the hybrid poplar tree plantation.
- Installing a collection and pumping system between the Tailings Area and the equalization pond in the Industrial Area will allow for the movement of both contaminated seepage and groundwater from the Tailings Area to the equalization pond for treatment at the onsite ATP. Since the existing ATP can satisfactorily remove dissolved cobalt from the contaminated groundwater, based on ATP monitoring data results, the increase in capital and operation, maintenance, and monitoring (OMM) costs associated with the installation of a collection and pumping system is considered low compared to the load reduction potential of cobalt to the environment.
- Although the use of a soil and vegetation cover is predicted to be effective in reducing the infiltration and deep percolation of water, an interceptor ditch is also recommended to achieve a greater level of water inflow reduction. The advantages of an interceptor drain include a reduction of surface water flow into the Tailings Area and an expected reduction of the influx of contaminants into the Moira River and Young's Creek. The unimpacted surface water runoff would be diverted to Young's Creek via the interceptor ditch.

The original recommended alternative was revised to provide for improved environmental protection and for cost savings measures. Revisions included:

- Reducing the silty clay loam layer from 150 cm to 100 cm, since the added 50 cm of material would provide little improvement due to the presence of the underlying sand layer and the compacted clay liner.

- The soil and poplar cover will extend down the face of both dam slopes to provide stability and to cover the crushed limestone, waste rock, and miscellaneous fill that was used to stabilize the dams walls. Waste rock was determined to be a human and animal health risk, due to dust exposure.
- All seepage and groundwater conveyance to the equalization pond will be surface mounted, heat traced, and metal clad to reduce the potential for erosion in the unlikely event of a pipe leak. Above-ground piping will also provide for a good visual check for leakage.

Data gaps and issues that were resolved prior to preparation of this report include the following:

- The structural integrity of both the east and west tailings dams walls were assessed as part of the Closure Plan development and were found to be stable enough to withstand the added stress of the proposed cover material (SRK, November 2003).
- The proposed enhancing environmental protection feature (i.e. to collect and pump contaminated seepage and groundwater from the Tailings Area to the equalization pond) was based on an assumption that the existing onsite ATP can cope with the added hydraulic load and can remove dissolved cobalt from the influent, and these assumptions were confirmed. (The ATP can satisfactorily remove dissolved cobalt, as noted above, and the added hydraulic load is addressed in the Industrial Area Closure Plan.)
- Geochemical studies have determined that the marginally contaminated material from Young's Creek cannot be used as cover material in the Tailings Area since it would create an adverse impact, as described in *Leaching Geochemistry of Young's Creek Clay Materials*, Draft Technical Memorandum (CH2M HILL, April 2004).
- The geochemical response of the tailings to the proposed capping has been evaluated. It is considered that the proposed capping design of the Tailings Area is appropriate and will not result in adverse geochemical conditions, as described in *Geochemistry and Geochemical Modelling of the Tailings Area, Deloro Mine Cleanup Project*, Draft Technical Memorandum (CH2M HILL, June 2004).

A Site-Specific Risk Assessment (SSRA) was carried out for the site to determine the potential for health risks to humans and animals. Due to the extent of cover recommended for the Tailings Area and its proposed depth of more than 1.5 m, no additional remediation for the Tailings Area was necessary.

Site-wide regulatory approvals that must be applied for and issued will be sought from the following agencies:

- Review and approval of the SSRA by the MOE Standards Development Branch (SDB).
- MOE certificates of approval for sewage and waste disposal; permits to take water, and Part V approval under the provincial *Environmental Protection Act*.
- Conservation Authority regulations: the *Fill, Construction, and Alteration to Waterways Regulation*.
- The Ministry of Natural Resources (MNR) is responsible for issuing Work Permits under several different Provincial Acts including the *Forest Fire Prevention Act*, *Lakes and Rivers Improvement Act*, and *Public Lands Act*.

- The federal Department of Fisheries and Oceans (DFO) is responsible for the *Navigable Waters Protection Act* and the *Fisheries Act*. The Canadian Coast Guard (CCG) may also be involved.
- Environmental Assessment (EA) and Canadian Nuclear Safety Commission (CNSC) licencing will be required to manage the radioactive and non-radioactive wastes on the site.

The Closure Plans for the Deloro Mine Site were developed based on the Ministry of Northern Development and Mines (MNDM) *Mining Act* requirements. The MNDM has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

This report contains information related to health hazard assessment (Section 4.6) and environmental and community health protection plans (Section 4.7) to minimize the potential impact of the closure activities on local residents and the environment.

OMM for the Tailings Area after the implementation of the Closure Plan include flushing the seepage and groundwater collection system, pressure testing, and routine pump maintenance; poplar cap grass cutting, rodent control, watering, and damaged plant replacement; erosion damage repair to the interceptor and drainage ditches and the soil cover; and a monitoring program for the cap.

The monitoring program can be summarized as noted in the following table:

MONITORING PROGRAM

Type of Monitoring	Description	Duration	Frequency
Poplar Cap Performance	Visual inspection of vegetative cover, erosion problems, tension cracks, seeps, TDR measurements	Indefinitely following Tailings Area capping	Semi-annual for Years 0 to 3 Annual after Year 3
Water Quality	Sampling and analysis of surface water at key selected locations	During the ditch excavation and well drilling stage of the project	Weekly during excavation
Water Quality	Sampling and analysis of groundwater and surface water at key selected locations Sampling and analysis at seepage and groundwater collection wells	Indefinitely following Tailings Area capping	Semi-annual for Years 0 to 5 Annual after Year 5
Pumping and Conveyance	Visual inspections and pressure testing	Throughout the pumping period	Monthly (with alarms in place)
Biomonitoring	Vegetation tissue and invertebrate sampling, soil moisture monitoring, visual observations	Indefinitely following Tailings Area capping	Annually for Years 0 to 5 Once every five years for the next 20 years Once every 10 years thereafter
ATP Influent/ Effluent Quality	Sampling and analysis of influent/effluent from ATP	Refer to the Closure Plan for the Industrial Area	Refer to the Closure Plan for the Industrial Area

During the implementation and operation of the rehabilitative measures at the site, there is a potential that malfunctions (i.e. in design, construction, or commissioning) or accidents (i.e. due to acts of nature) could occur. These malfunctions and accidents can adversely

affect remediation activities and OMM of the site, resulting in delays or costly mitigation measures. These events must be considered and mitigation measures must be developed to ensure environmental impacts are minimal and acceptable. This report contains mitigation measures for potential malfunctions and accidents for the short-term during preparation activities, medium-term during remediation activities, and during the long-term OMM activities.

The Tailings Area work was divided into work packages. Sequencing of work packages is in the order presented below:

IDENTIFICATION OF WORK PACKAGES

Package I.D.	Work Package Description
TA-WP#1	Contractor set-up, access routes preparation, construction of washpad and mobile washer, installation of surface water control items, and temporary road construction to Tailings Area.
	Clearing and grubbing the perimeter of the Tailings Area, especially along the northern edge to allow for placement of and grading for the interceptor ditch. Clearing and grubbing to remove trees from the tailings surface and from the rock outcroppings within the Tailings Area.
TA-WP#2	Placement of the rip rap and geotextile at the toe of the tailings dams walls. Placement of the geotextile along the slope of the crushed limestone berm portion of the dams walls and on the crushed limestone covering the tailings.
TA-WP#3a	Capping the tailings surface and the dam slopes to the toe of the dams walls with 0.3 m clay, 0.3 m sand, 1.0 m silty clay loam, and 0.15 m topsoil, then seeding with grass.
	Construction of the interceptor ditch for the north and east portions of the Tailings Area and the drainage ditches at the south portion of the Tailings Area that will occur towards the end of the earthworks and prior to planting the poplar plantation since it will be incorporated into the final cover.
TA-WP#3b	Installation of hybrid poplar trees (cuttings or bareroot) and the irrigation system.
TA-WP#4	Installation of groundwater collection wells, pumps, and power supply to the pumps. Construction of heated enclosures and overland piping from the Tailings Area to the equalization pond.

The anticipated construction impacts and mitigation measures are as follows:

ANTICIPATED CONSTRUCTION IMPACTS AND MITIGATION MEASURES

Construction Impacts	Mitigation Measures
Clearing and grubbing of trees and shrubs during site preparation	Altered areas will be revegetated with poplar plantation and grasses.
Suspended particulates in air from heavy equipment/vehicles adversely affecting air quality	Dust suppression methods will be utilized on an “as needed” basis.
Vegetation removal for temporary road construction or existing road upgrades to accommodate heavy vehicles	Roads not required for the future OMM of the site will be excavated, backfilled with appropriate material and revegetated to blend in with existing cover/cap requirements.
Suspended sediment in surface water	Diversion dams/trenches, and geotextile silt fencing will be used to isolate surface water flows from active excavation areas. Sediment settling/retention ponds may be required.
Rock blasting during trench and ditch installation (if required)	Performed in accordance with the applicable regulations with blasting mats.

The implementation schedule of work packages is presented below:

IMPLEMENTATION SCHEDULE OF WORK PACKAGES

Package I.D.	Work Package Implementation Schedule
TA-WP#1	Contractor set-up, prepare access routes, construct washpad/mobile washer, surface water control installation, construct temporary road to Tailings Area, and clear and grub in Year 1.
TA-WP#2	Place rip rap and geotextile in Year 1.
TA-WP#3a	Install cap (sand, HDPE perforated collection pipe, soil, clay, grass cover), interceptor ditch and drainage ditches in Year 1 and maintain during the following three years to help minimize tree mortality.
TA-WP#3b	Plant poplar plantation and install irrigation equipment in Year 2.
TA-WP#4	Drill groundwater collection wells in Year 2, install electrical service and pumps and construct heated enclosure. Install overland piping in subsequent year(s) to coincide with completion of activities in other areas that piping installation is dependent on (i.e. Industrial Area).

The estimated cost of each work package is presented as follows:

Package I.D.	Work Package Cost
TA-WP#1	$283,500
TA-WP#2	$313,600
TA-WP#3	$6,694,100
TA-WP#4	$216,000

The total costs associated with the recommended alternative include a capital cost of $7,507,200 and an annual (weighted) OMM cost of $88,020 for a net present value (NPV) of $1,293,200 for a selected 20-year period. The net present value of the recommended alternative, assuming an effective interest rate of five percent and the planning horizon of 20 years, is $8,800,400. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

Post-closure conditions are expected to provide a setting in the Tailings Area that is in significant contrast to the existing conditions. The soil cover and hybrid poplar plantation will provide a cover that will blend into the current surrounding forested area.

The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment and groundwater modelling studies (see Section 2). Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The

comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

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List of Acronyms

AAQC	Ambient Air Quality Criteria
ATP	Arsenic Treatment Plant
C of A	Certificate of Approval
CCG	Canadian Coast Guard
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
COC	Chemical of Concern
DFO	Department of Fisheries and Oceans
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECHPP	Environmental and Community Health Protection Plan
EIS	Environmental Impact Study
EPA	Environmental Protection Act
FA	Federal Authority
GHASP	General Health and Safety Plan
GST	Goods and Services Tax
GUCSO	Guideline for Use at Contaminated Sites in Ontario
HADD	Harmful Alteration, Disruption or Destruction
HDPE	High-density polyethylene
HELP	Hydraulic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
LLRW	Low-Level Radioactive Waste
masl	Metres Above Sea Level
MNDM	Ministry of Northern Development and Mines
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MOEE	Ministry of Environment and Energy
MRCA	Moira River Conservation Authority
NPV	Net Present Value
NSCA	Nuclear Safety and Control Act
NWPA	Navigable Waters Protection Act
OCWA	Ontario Clean Water Agency
OMM	Operation, Maintenance, and Monitoring
OWRA	Ontario Water Resources Act
PC of A	Provisional Certificate of Approval
PPE	Personal Protective Equipment
PSW	Provincially Significant Wetland
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
QC	Quinte Conservation
RA	Responsible Authority
RSC	Record of Site Condition

SDB	Standards Development Branch
SLERA	Screening Level Ecological Risk Assessment
SSRA	Site-Specific Risk Assessment
TDR	Time Domain Reflectometry
TERP	Transportation and Emergency Response Plan
TOR	Typical Ontario Resident
TSP	Total Suspended Particulate
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WNSL	Waste Nuclear Substance License

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Figures

1. Introduction

1.1 Background

1.1.1 Deloro Mine Site

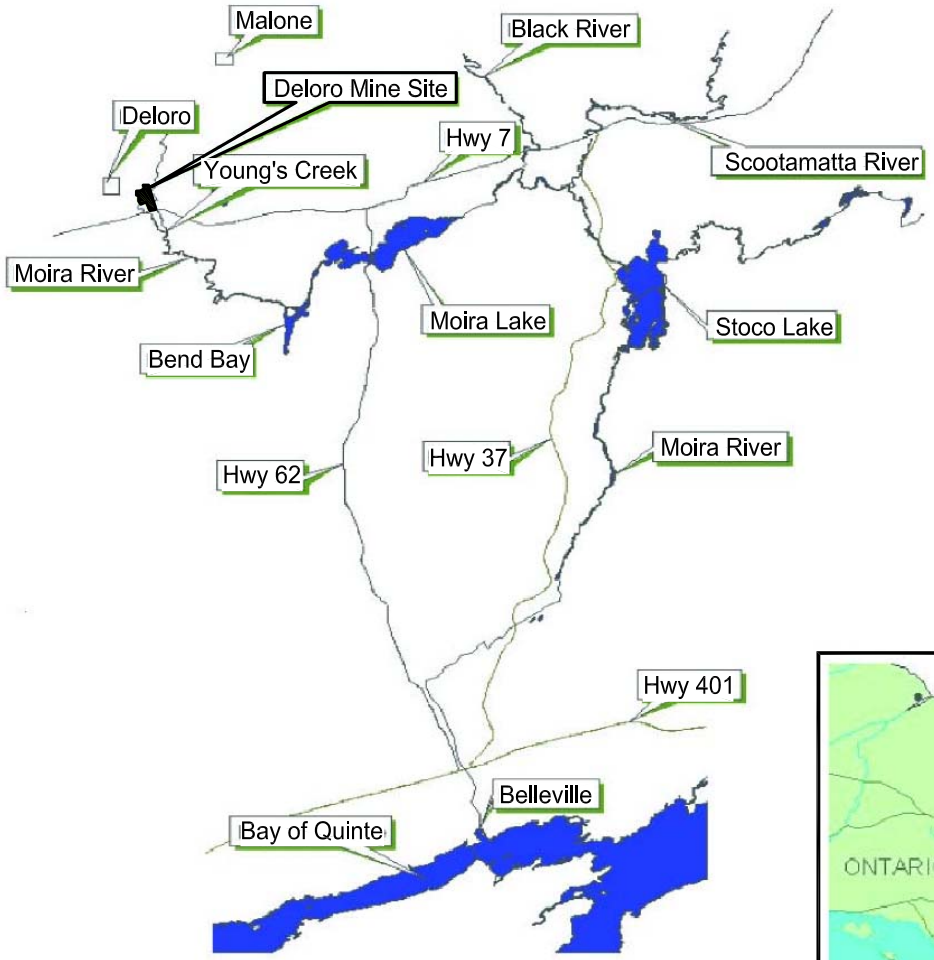
The Deloro site is located in Eastern Ontario along the banks of the Moira River (Figure 1-1) east of the Village of Deloro (Figure 1-2). The former refinery/smelter site (Industrial Area) is approximately 25 ha in area and is located adjacent to the west bank of the Moira River. The Tailings Area is located east of the Industrial Area between the east side of the Moira River and the west side of Young's Creek. The entire property, which includes the Industrial Area, Tailings Area, Mine Area, and the onsite portion of Young's Creek, is approximately 202 ha in area (CH2M HILL, February 2002).

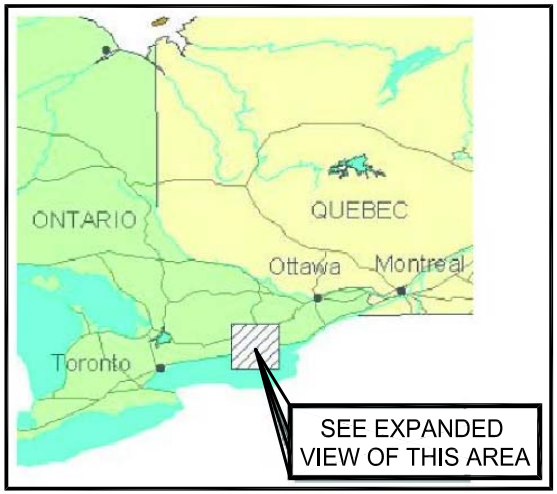
Access to the mine site is via Deloro Road, which is accessed from Highway 7, approximately 4 km east of Marmora. The principal population centres in the area are the Village of Deloro (pop. 180), and the Villages of Marmora (pop. 1,700) and Madoc (pop. 1,400), located approximately 5 km southwest and 10 km east of the mine site, respectively.

The Deloro site began operation as a gold mine in the 1860s and evolved over the next century to mine and refine gold, as well as smelting and refining of a number of other elements including arsenic, silver and cobalt. It was the first plant in the world to produce cobalt commercially and was also a leading producer of stellite, a cobalt-chromium-tungsten alloy. Concentrates from uranium extraction were imported to the site and further processed to extract cobalt. Arsenic-based pesticides were produced from the by-products of smelting operations and continued as a main activity at the site until the market collapsed in the late 1950s.

A century of handling hazardous materials and chemicals has resulted in significant environmental degradation of the Deloro Mine Site. Large quantities of refining slag, mine tailings, calcium arsenate, and arsenical pesticides remained at the site. Fuels, chemicals, and raw materials, such as sulphuric acid, coke, lime, soda ash, caustic soda, liquid chlorine, salt, scrap iron, sodium chlorate, and fuel oil were handled at the site. Radioactive slag and tailings were produced as a result of the re-refining of by-products from uranium refining.

The Ontario government stepped in to take control of the site in 1979 due to failure of the owner to control environmental releases. The Ministry of the Environment (MOE) has been in care and control of the site since that time. Several rehabilitation actions have been implemented at the site that have significantly reduced releases from the site. In 1979, the annual average loading of arsenic to the Moira River was 52.1 kg/day. Since the Arsenic Treatment Plant (ATP) located in the Industrial Area of the site was put into operation in 1983, the arsenic loading to the river has been reduced by more than 80 percent, to an annual average of less than 10 kg/day. However, further work is required to reduce releases to acceptable levels and to secure the site for the long term. CH2M HILL Canada Limited (CH2M HILL) was retained to provide consulting engineering and project management services for the Deloro Mine Site Cleanup.





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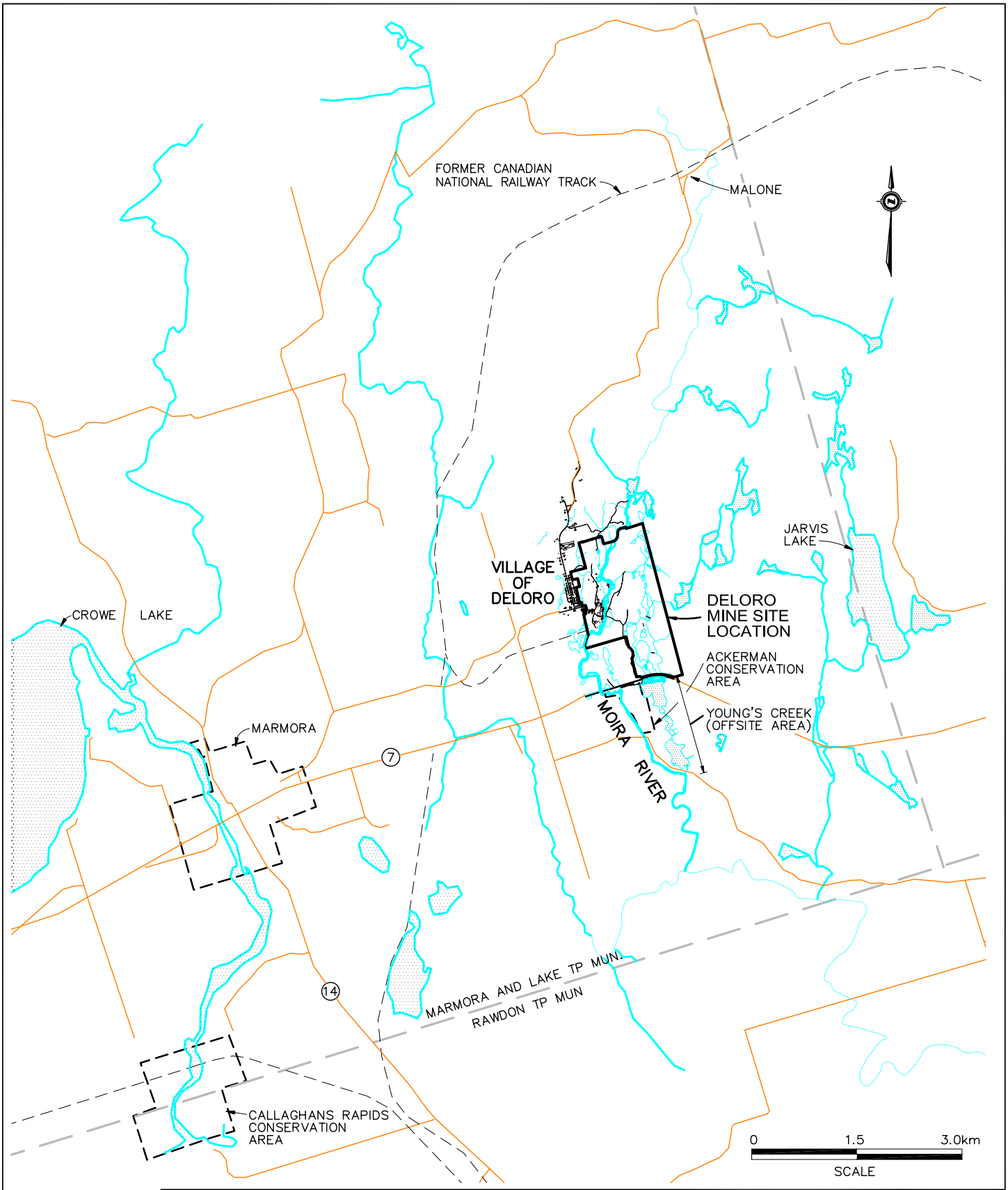
DELORO MINE SITE CLEANUP

FIGURE 1-1
SITE LOCATION PLAN

PROJECT No. 119548



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DELORO MINE SITE CLEANUP

FIGURE 1-2
DELORO MINE SITE LOCATION

PROJECT No. 119548

1.1.2 Rehabilitation Alternatives

CH2M HILL was retained by the MOE to develop and implement a comprehensive rehabilitation program for the closure of this former mine site. As part of this comprehensive rehabilitation program, CH2M HILL evaluated a broad range of rehabilitation alternatives and identified a recommended alternative for further development for each of the four areas within the mine site's footprint, as shown in Figure 1-3. The limits of these four areas have been developed based on historical land use and waste disposal practices. The four areas are:

- The Industrial Area, where smelting and refining of the various ores were carried out
- The Tailings Area, where the by-products of the production phase were stored
- The Mine Areas, on both the east and west sides of the Moira River
- The Young's Creek Area, which has been impacted from historical releases from the Tailings Area

The rehabilitation alternatives reports prepared by CH2M HILL are as follows:

- *Deloro Mine Site Cleanup – Industrial Area Rehabilitation Alternatives* (December 2003)
- *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives* (October 2003)
- *Deloro Mine Site Cleanup – Mine Area Rehabilitation Alternatives* (October 2003a)
- *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives* (May 2003)

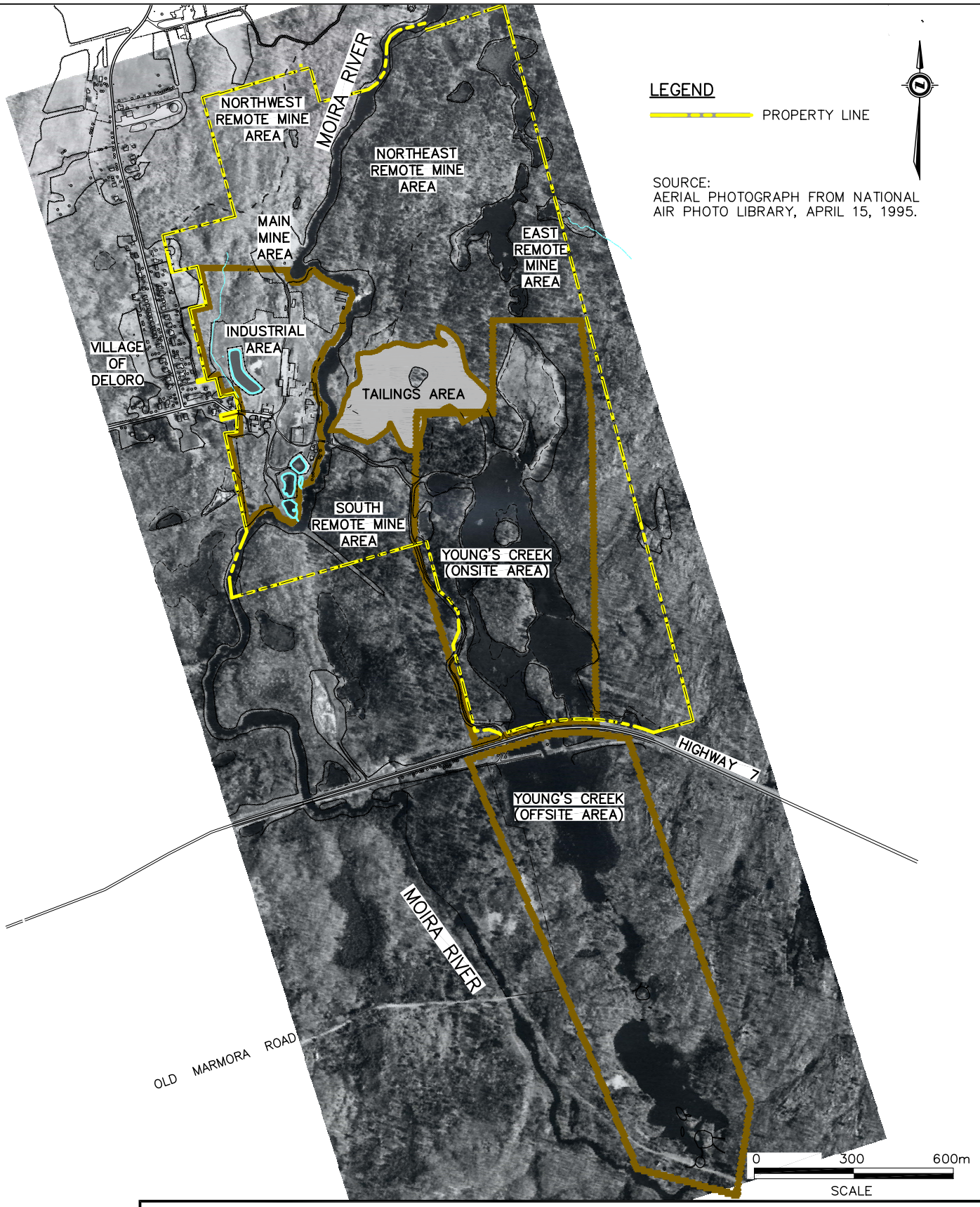
1.1.3 Purpose of this Closure Plan

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site to mitigate, within reason, any unacceptable impacts on human health or the environment. As part of this overall objective, several area-specific objectives have been developed. Achieving these objectives, in conjunction with the other area-specific objectives, will aid in the successful rehabilitation of the Deloro Mine Site.

The Closure Plans for each of the four areas of the site are based on the site-wide closure objectives identified in the report entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998), including area-specific closure objectives (see Section 1.3), and the recommended rehabilitation alternatives developed for each area. The recommended alternatives are further developed in the four Closure Plans as follows:

- *Deloro Mine Site Cleanup – Industrial Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Tailings Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Mine Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Young's Creek Area Draft Closure Plan*

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed to satisfy in general the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The latter document includes provisions for protection of the environment.



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DELORO MINE SITE CLEANUP

FIGURE 1-3: DELORO MINE/REFINERY SITE SHOWING THE INDUSTRIAL, MINE, TAILINGS AND YOUNG'S CREEK AREAS - DELORO, ONTARIO

PROJECT No. 119548

The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment and groundwater modelling studies (see Section 2). Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

An integrated technical cleanup plan will be prepared to present a summary of the four Closure Plans and to optimize and prioritize the remedial actions.

1.1.4 Organization of Report

This report consists of ten sections, including the introduction. Section 2 summarizes the findings of other technical studies undertaken to support the Closure Plans. A detailed description of the recommended alternative for the Tailings Area is presented in Section 3 including site security and safety, building demolition, waste removal and handling, waste isolation and containment, water management, mine workings, crown pillars and surface workings, final site grading, and site rehabilitation and revegetation. Section 4 presents an implementation plan for the selected alternative including identification and sequencing of work packages, identification of anticipated construction impacts and mitigation measures, an implementation schedule, a cost opinion, a health hazard assessment, an environmental and community health protection plan, and other operational procedures. Section 5 describes operation, maintenance, and monitoring (OMM) efforts outlined under the recommended remedial alternative. A recommended monitoring program is discussed in Section 6, focusing on physical monitoring, chemical stability and water quality, biomonitoring and site management. Potential malfunctions and accidents and corresponding mitigation measures are examined in Section 7. Section 8 details the expected post-closure conditions and uses of the site. Known and anticipated approval requirements are outlined in Section 9, and Section 10 lists the references used in the preparation of this report. The detailed cost opinion is provided in Appendix A.

1.2 Related Reports and Studies

A list of reports and other documents referenced in this document is provided in Section 10. Related reports and studies are on public record and available for review from the Kingston MOE office.

The Ontario Ministry of Northern Development and Mines (MNDM) recommends in *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995) that the Closure Plan include sections on "Current Environmental Conditions", a "Project Description", and a range of "Rehabilitation Alternatives". These three sections were provided in detail for the Tailings Area in the document *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives, Final Report* (CH2M HILL, October 2003) and are therefore not repeated in this report. The exception is the rehabilitation alternatives, which are listed in Section 1.4 below.

1.3 Cleanup Approach and Criteria

Extensive previous investigation and evaluation has been undertaken at the Deloro Mine Site. Based on strategic decisions made by the MOE in the early 1990s, the most viable solutions for management of residuals at the Deloro Mine Site involve onsite management through isolation and containment techniques. An approach that includes cleanup to "natural background" is prohibitively costly and is not considered to be the most prudent expenditure of public funds. Instead, a more pragmatic approach has been adopted in which mitigative action is directed at risk reduction. In this approach, risks to both human health and the environment are considered under both the current and reasonably expected future land uses. This approach has been recognized as an option in the MOE's *Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997), in which it is referred to as the Site-Specific Risk Assessment (SSRA). The SSRA is the approach selected by the MOE as proponent for the Deloro site rehabilitation.

The strategic direction for site cleanup, involving the onsite management of wastes through isolation and containment methods as primary remediation techniques, is described in the report entitled *Deloro Mine Rehabilitation Project - Development of Closure Criteria, Final Report* (CG&S, October 1998). This translates into the following project objective:

> *To successfully rehabilitate the Deloro Mine Site to mitigate any unacceptable impacts on human health or the environment in compliance with relevant environmental policies and regulations.*

To satisfy this objective, specific site-wide and distinct area closure objectives were developed. The site-wide closure objectives are as follows:

1. Reducing the loading of arsenic and other contaminants to the Moira River
2. Compliance with appropriate regulations and policy
3. Satisfying the general intent of the *Mining Act* and related draft regulations
4. Reducing/controlling impact/risk to acceptable levels
5. Demolition of unneeded buildings to ground level
6. Prioritizing remedial action implementation according to risk reduction
7. Minimizing perpetual OMM
8. Restoration of the site to reflect its natural surroundings
9. Securing the site for the indefinite future
10. Managing the wastes over the smallest possible area

The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to achieve Provincial Water Quality Objectives (PWQO) at the intersection of the Moira River and Highway 7 (CG&S, October 1998). Monitoring will be performed to assess actual performance. Contingency measures have been incorporated as part of the recommended alternative for each area of the site and are further developed as part of the Closure Plans. These site-wide closure objectives were further refined into area-specific closure objectives for each area of the site.

The following closure objectives developed for the Tailings Area reflect the overall remedial objectives for the Deloro site:

1. Develop a rehabilitation Closure Plan supported by a Site-Specific Risk Assessment (SSRA)
2. Develop/implement risk reduction plans according to site-wide priorities
3. Implement measures to eliminate exposed wastes at ground surface
4. Manage contaminated groundwater/seepage/runoff
5. Promote revegetation of the Tailings Area to match native conditions (i.e. to match current natural surroundings)
6. Contain tailings for the long-term consistent with accepted design practice
7. Provide assurance of dam stability through testing and, if required, dam stabilization

1.4 Alternatives Considered

As previously noted, the Deloro Mine Site cleanup is being conducted according to the *Guideline for Use at Contaminated Sites in Ontario (GUCSO)* (MOE, 1997) following the SSRA option. The approach has been adapted or enhanced to meet other regulatory or best management practices including the *Canadian Environmental Assessment Act* (CEAA).

A process was developed to generate potential remedial alternatives and select a recommended alternative for all areas of the Deloro site. This process is described in the Alternatives report *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives, Final Report* (CH2M HILL, October 2003). Initially, conceptual remediation methods that could have addressed some or all of the issues identified for each respective area of the site were identified. For instance, a method may address groundwater issues but not impacted sediment. These methods were evaluated with a screening process to identify which methods had the greatest potential to address the issues at the site, either alone or in combination with other methods. Improbable methods that did not have significant potential to contribute to a viable solution were eliminated early in the process. This resulted in a list of primary remediation methods that were retained for further evaluation.

The primary remediation methods were combined with enhancing features, based on the judgement and experience of the project team, to create a number of comprehensive remediation alternatives that addressed all of the environmental issues at the site. These comprehensive remediation alternatives were subsequently evaluated in a two-step process. The screening level evaluation again served to eliminate comprehensive remediation alternatives (as opposed to conceptual remediation methods that had been previously screened) that were unlikely to meet all of the remediation needs for the area. This second level of screening led to a short list of comprehensive remediation alternatives that were the subject of a more detailed evaluation. The detailed evaluation led to the identification of a recommended remediation alternative, which would be developed further and subsequently implemented to address the environmental issues at the site.

The following are the main components that were used to generate the comprehensive remediation methods:

- Cover with soil and vegetation
- Collect and treat contaminated seepage and groundwater (associated with the east and west dams walls of the tailings impoundment)
- Divert surface runoff away from the Tailings Area

In total, six comprehensive remediation alternatives were generated for the Tailings Area:

1. Cover the surface of the Tailings Area with soil and vegetation.
2. Cover the surface of the Tailings Area with soil and vegetation and divert surface runoff away from the Tailings Area.
3. Cover the surface of the Tailings Area with soil and vegetation and collect and treat contaminated seepage and groundwater. (In this option, collected seepage and groundwater are directed to a natural treatment system [i.e. wetland and peat bed].)
4. Cover the surface of the Tailings Area with soil and vegetation and collect and treat contaminated seepage and groundwater. (In this option, collected seepage and groundwater are directed to the existing onsite ATP.)
5. Cover the surface of the Tailings Area with soil and vegetation, divert surface runoff away from the Tailings Area and collect and treat contaminated seepage and groundwater. (In this option, collected seepage and groundwater are directed to a natural treatment system [i.e. wetland and peat bed].)
6. Cover the surface of the Tailings Area with soil and vegetation, divert surface runoff away from the Tailings Area and collect and treat contaminated seepage and groundwater. (In this option, collected seepage and groundwater are directed to the existing onsite ATP.)

1.5 Overview of the Recommended Alternative

The recommended remediation alternative was based on reducing water contact and infiltration through the surface of the Tailings Area, treatment of contaminated seepage and groundwater during the vegetation establishment period and after, as required, and reducing the amount of surface run-on from the surrounding environment. Seepage production is predicted to be reduced sufficiently that the seepage contribution will be negligible, or that seepage volume and contaminant loading will be reduced such that a natural treatment system can be installed to provide long-term passive water quality improvement.

1.6 Key Components and Recommended Alternative

The recommended alternative for the Tailings Area, consistent with the site-wide and area-specific closure objectives is as follows:

- To cover the surface of the existing crushed limestone cap with an engineered soil cover and vegetation (hybrid poplar trees are expected to provide the greatest benefit)

- Collection and pumping of contaminated seepage and groundwater associated with the tailings impoundment for treatment
- Construction of an interceptor ditch to divert unimpacted surface water runoff away from the Tailings Area

For a period of four to seven years (during which the hybrid poplars are expected to reach maturity), it is expected that the contaminated seepage and groundwater from the Tailings Area will be directed to the equalization pond located in the Industrial Area via a collection and pumping system for treatment. This is consistent with previous work (Geocon, 1986) that recognizes the compatibility of this approach to the surrounding environment, while effectively providing contaminant loading reduction to the Moira River and Young's Creek.

A description of the components of the recommended alternative follows.

1.6.1 Site Preparation

Prior to commencing the remedial work, site preparation work will be completed that includes mobilization of equipment (excavators, trucks, site trailers and other equipment), clearing and grubbing, construction of access roads, and establishment of temporary services. Confirmation that heavy construction equipment can be supported on the Tailings Area will be evaluated during the detailed design stage.

1.6.2 Construction of Engineered Soil Cover and Hybrid Poplar Trees Plantation

The preferred choice of soil cover consists of a layer of silty clay loam in combination with topsoil, sand, and compacted clay materials. A geotextile would separate the cover soils from the crushed limestone to reduce the potential of migration of soil into the voids of the existing crushed limestone layer. The topsoil provides the initial rooting medium for the poplar trees, while the silty clay loam and sand provide the necessary water storage capacity that will increase the effectiveness of the poplar trees to draw up the stored water and evapotranspire it to the atmosphere. The compacted clay layer functions as a low-permeability layer to minimize percolation of water into the underlying limestone cover and tailings (red mud). Based on the findings of the *Feasibility Study for a Combined Soil Cover and Poplar Tree Cap in the Tailings Area, Final Report* (CH2M HILL, May 2002), the construction of a soil cover incorporating a 100 cm silty clay loam layer, in addition to a 15-cm topsoil layer, a 30-cm sand drainage layer, and a 30-cm compacted clay base is predicted to be sufficient to achieve deep percolation reductions of 83 percent above existing conditions.

An irrigation system will be installed and operated for a period of approximately three years during the maturation of the hybrid poplar tree plantation.

1.6.3 Construction of Interceptor Ditch System

Although the use of an engineered soil cover and vegetation is predicted to be effective in reducing the infiltration and deep percolation of water, an interceptor ditch is also recommended to divert unimpacted surface water runoff away from the Tailings Area. The advantages of an interceptor ditch include a reduction of surface water flow into the Tailings

Area and an expected reduction of the influx of contaminants into the Moira River and Young's Creek.

An effective interceptor ditch could be constructed along the north and east side of the Tailings Area, where reduction in the effective catchment area can be achieved. The unimpacted surface water runoff would be diverted to Young's Creek via the interceptor ditch. The ditch will be incorporated into the cap design such that the topography of the lands north and northeast of the Tailings Area will slope into the ditch. Trees and shrubs along this northern and northeastern section will be removed to allow for ease of integration of the existing slope at the perimeter of the Tailings Area into the interceptor ditch design.

1.6.4 Collection and Treatment

Based on loading calculations of arsenic, cobalt, and copper to the Moira River and Young's Creek, it was determined that seepage from both the east and west sides of the Tailings Area contributes significant amounts of cobalt and copper to the Moira River and Young's Creek system on a site-wide basis (CH2M HILL, *Deloro Mine Rehabilitation Project – Development of a Sitewide Water and Load Balance,* March 2002). A downgradient collection and pumping system will be installed to capture contaminated seepage, beneath the east and west tailings dams walls, and associated contaminated groundwater. The contaminated water will be conveyed by overland piping to the equalization pond for treatment at the existing ATP. The main contaminant of concern is cobalt, although the seepage contains lesser concentrations of copper and arsenic. Since the existing ATP can satisfactorily remove dissolved cobalt from the onsite contaminated groundwater, based on ATP monitoring data results, the increase in capital and OMM costs associated with the installation of a collection and pumping system is considered low compared to the load reduction potential of cobalt to the environment.

1.6.5 Dam Stability

It is the opinion of Steffen, Robertson & Kirsten (Canada) Inc. (SRK) that under existing conditions that the integrity of neither of the tailings dams walls is in question. The 1986 stability assessment by Geocon (Geocon, 1986) confirmed that the dams walls are safe against possible failure mechanisms, and since that time both dams walls have been stabilized through downstream buttressing when the crushed limestone cover was placed.

Based on SRK's engineering judgment of the current condition of the tailings dams walls, and assuming the final cover (approximately 2-m thick) is placed across the dams walls as a further buttress (as illustrated in Figures 3-3 and 3-4), using light construction equipment, SRK believes there should be no cause for concern with respect to long-term dam wall stability. This was SRK's recommended alternative for interfacing the final cover with the tailings dams walls (SRK, May 2004).

2. Technical Studies and Supporting Documentation

2.1 Human Health and Ecological Risk Assessment

The MOE has developed guidance documents specific to the SSRA approach, which have been followed for this project. CH2M HILL has conducted SSRAs for both the human health and ecological risks for all areas of the site, based on the remediation alternatives recommended for each area of the site and for various exposure scenarios and receptors. Results of these simulations have been used in the Closure Plans to modify and optimize the conceptual remediation designs first presented in the rehabilitation reports, as well as to satisfy the site-wide closure objectives. The SSRA also supports a Pathways Analysis, which is anticipated as part of the Canadian Nuclear Safety Commission (CNSC) license application (see Section 2.3).

In support of the rehabilitation program and as part of the development of the final cleanup plan, CH2M HILL completed a draft screening level ecological risk assessment (SLERA) and a draft human health risk assessment (HHRA) to assess the risks associated with the Deloro Mine Site and Young's Creek offsite area following rehabilitation. The risk assessment was completed for the entire site, including the four main areas. This section presents a summary of the findings of the Mine site SSRA and Young's Creek offsite area SSRA, respectively. Complete details concerning the HHRA and SLERA are provided in the following reports:

- *Deloro Mine Site Cleanup – Deloro Mine Site Site-Specific Risk Assessment, Draft Report*. (CH2M HILL, May 2003a).
- *Deloro Mine Site Cleanup – Offsite Young's Creek Site-Specific Risk Assessment, Draft Report*. (CH2M HILL, May 2003b).

2.1.1 Summary of SSRA Results

The results of the draft SSRAs performed at the Deloro Mine Site and in Offsite Young's Creek are summarized below for the expected post-closure conditions. Additional information is provided in the executive summaries of the respective draft reports.

Human Health Risk Assessments (HHRA)

- All chemicals of concern (COCs), with the exception of arsenic, show results below the MOE recommended target of 1×10^{-6} for carcinogenic risk. It is the opinion of CH2M HILL that comparison to the typical Ontario resident (TOR) is more appropriate for qualification of carcinogenic arsenic risk. The carcinogenic risks for arsenic were determined to be less than the risk to a TOR for all scenarios, receptors, and routes of exposure.

- Risk identified at levels greater than the MOE recommended target hazard quotient (HQ) of one for non-carcinogenic risk were identified for the onsite Child Recreational User due to exposure to soil (onsite), sediment (onsite and offsite) and surface water (offsite). The elevated post-closure risk results may be mitigated with expansion of the areas to be excavated and/or covered as part of the recommended rehabilitation alternative, or, the results may be confirmed with additional sampling to confirm assumptions made in order to fill in the data gaps (see further discussion in Section 2.1.4 below).
- Young's Creek offsite post-closure Recreational User receptor risks were well below the comparison values previously identified. This may indicate that the rehabilitation effort originally proposed as part of the recommended rehabilitation alternatives reports can be reduced, assuming it also meets the requirements of acceptable risk to ecological receptors.
- Carcinogenic and non-carcinogenic risk due to ingestion of arsenic in onsite and offsite diet media (fish, ruffed grouse, berries) was greater than both the TOR and the HQ of one, respectively, for the Child and Adult Recreational Users. Confirmation of the presence and consumption of the diet media, as well as additional ecological data, is required to confirm these results.

Screening Level Ecological Risk Assessments (SLERA)

- Arsenic and cobalt are the COCs that are the main drivers of the elevated risk to onsite ecological receptors, as well as both pre- and post-closure Young's Creek offsite ecological receptors. Additional metals such as nickel, copper, chromium, and boron have also been identified as contributing to elevated risk to ecological receptors onsite and offsite.
- The results show that it is the concentration of the aforementioned COCs in soil that is of primary concern; however, elevated risk results have also been determined due to exposure to COCs in sediment and surface water.
- Almost all of the ecological receptors modelled show elevated risk at the screening level due to one or more COCs for one or more routes of exposure.
- A significant degree of uncertainty is associated with the draft results due at the screening level to lack of site-specific information and assumptions made in order to fill in data gaps.

2.1.2 Key Points

The following items should be considered in determining a path forward for the SSRA:

- The draft risk results for some pathways and receptors (both ecological and human) were not calculated using site-specific data, instead, engineering assumptions and literature-derived information were used.
- The risks to ecological receptors are not conclusive given the information that is currently available.
- The results of the draft human health risk assessment indicate that further risk reduction efforts are required should the future land use allow recreational users on the onsite property.

- Risk to both ecological and human health receptors may be mitigated by extending cleanup to a larger area, or by addressing the aforementioned data gaps by undertaking a focused field program.

2.1.3 Primary Issues of Concern

Based on the information presented above, there are two issues of primary concern. These arise because previous sampling work has focused on delineation of impacted areas for cleanup with relatively little focus on the post-closure conditions. The two primary issues are: (i) the absence of analytical data for certain chemicals in specific media, and (ii) the lack of site-specific information required to evaluate the potential risk due to exposure to the chemicals present.

2.1.4 Revisions to Recommended Rehabilitation Alternatives

The recommended modifications to the recommended rehabilitation alternatives, which were identified through completing the draft SSRAs, included:

- Expansion of coverage around the western perimeter of the Industrial Area
- Total coverage of the Main Mine Area
- Excavation and/or capping of selected areas west of the Tailings Area to the Moira River
- Excavation of sediment from the Young's Creek Offsite area just south of Highway 7
- Excavation of sediment from the Young's Creek Offsite area just north of the confluence with the Moira River

In addition, in order to prevent exposure to burrowing animals as part of the SLERA (as well as due to the potential risk of transmigration of contaminants via tree roots), the thickness of any capped areas was increased to be at least 1.5 m[1]. These recommended modifications to the recommended rehabilitation alternatives are addressed in the Closure Plan for each area of the site.

2.1.5 SSRA Recommendations

The SSRAs provided to the MOE documented the presence of metal contaminant-related issues within the Deloro mine onsite area and Young's Creek offsite area under the post-closure condition for the recommended rehabilitation alternative. While the SSRA results did not show unacceptable risk under most conditions, it also indicated that there were potential risks to plants and animals residing within these areas, as well as to humans spending time on the respective properties, in some circumstances. The extensive characterization work at the site has focused on the areas requiring remediation, with less effort directed to areas that will remain post-closure. As a result, the data used to define the nature and extent of post-closure contamination and subsequent risk, or to establish acceptable risk-based cleanup levels, is being augmented through further investigative work. Further, the conclusions for potential risks to ecological receptors/valued ecosystem components (VECs) were primarily based on published reference values consistent with a

[1] With exception, the cap thickness over slag and waste rock in the Industrial Area and Mine Area, respectively, was set at 0.65 m since these materials are not bioavailable.

screening level risk assessment (e.g. GUCSO). These values are not specific to this site, the activities that have taken place, or the types of contaminants present. In order to confirm that the recommended alternatives are appropriate and that remediation is not required over a broader area of the site (beyond the areas identified in the Closure Plans), additional site information is being collected and further risk evaluation is underway.

The results of the supplementary site information and risk assessment will be used to fill in the data gaps, increase the confidence in the risk evaluation, and update the draft results of the HHRA and SLERA for both the Deloro Mine Site SSRA report and Young's Creek Offsite SSRA report. The revised reports will be prepared in a format that is suitable for submission to the Standards Development Branch (SDB) of the MOE for their review following the additional work. If necessary, the Closure Plans will be revised to address additional areas of the site that need to be capped or excavated.

The following briefly lists the studies that are ongoing to verify and substantiate the conclusions of the SLERA and the HHRA:

- Additional chemical characterization of onsite soil, sediment, and surface water
- Collection of biota co-located with soil, sediment, and surface water samples for evaluation of site-specific bioaccumulation
- Biological and physical surveys within the Young's Creek onsite area
- Toxicity testing of the Young's Creek onsite area
- Bioavailability of COCs in soil, sediment, and surface water

2.2 Modelling Studies and Predictive Assessments

The following section details modelling studies conducted to support the rehabilitation efforts at the site.

2.2.1 Groundwater Flow Simulation

Groundwater flow simulations were completed by CH2M HILL to support the development of cleanup plans for the Deloro Mine Site. The following findings, related discussion and recommendations of the groundwater flow modelling are drawn from the report, entitled *Deloro Mine Site Cleanup – Groundwater Flow Simulation, Draft Report* (CH2M HILL, July 2003).

Simulations were designed to represent the conditions that will result following implementation of the rehabilitation alternative in the Alternatives Reports for the Industrial Area and Tailings Area. These simulations directly predict how groundwater flow will be affected and indirectly how contaminant transport will be reduced. Contaminant transport modelling was not carried out, except in a rudimentary fashion, because of the complexity of geochemical reactions that may take place along the groundwater flow path and the lack of detailed geochemical data required to support contaminant transport modelling.

Simulations were completed by first calibrating a groundwater model to the existing site conditions, then overlaying the proposed rehabilitation alternative for the Industrial Area and Tailings Area to predict the expected performance. A three-dimensional groundwater

flow model was created to simulate the proposed cleanup scenarios in a model domain that encompassed the Deloro Mine Site and surrounding areas. MODFLOW 2000 was selected as the simulation code for this study. The model consisted of four layers: two layers to represent the surficial deposits and two layers to represent bedrock. Hydraulic properties (hydraulic conductivity) and stratigraphy and layer thickness were obtained from drilling and field testing. Recharge (infiltration) values were obtained from the HELP (Hydraulic Evaluation of Landfill Performance) model, except for calculated values for the Deloro communal septic system. Simulations were focused on the Industrial Area and the Tailings Area due to the complexity of the site conditions and the remedial alternatives being considered.

2.2.2 Tailings Area

The Tailings Area remediation scenarios that were simulated included the following three cover designs that were developed previously in the *Feasibility Study for a Combined Soil Cover and Poplar Tree Cap in the Tailings Area, Final Report* (CH2M HILL, May 2002). Groundwater collection wells located downstream of the east and west tailings dams walls were also simulated:

1. Alternative 1 – A composite cover consisting of, from the top down, 15 cm topsoil, 30 cm of silty clay loam, 30 cm of sand, and 30 cm of compacted clay over the existing crushed limestone on top of the tailings
2. Alternative 2 – A composite cover consisting of, from the top down, 15 cm of topsoil, 100 cm of silty clay loam, 30 cm of sand, and 30 cm of compacted clay (recommended alternative: see Section 3.4.1)
3. Alternative 3 – A composite cover consisting of, from the top down, 15 cm of topsoil, 150 cm of silty clay loam, 30 cm of sand, and 30 cm of compacted clay

The existing conditions model was run first to establish system dynamics. HELP modelling was carried out for the existing Tailings Area model and produced a recharge (infiltration) of 359 mm/yr. The Tailings Area was represented in the MODFLOW model with four layers: Layer 1 represented the tailings, Layer 2 represented the underlying clay layer, Layers 3 and 4 represented the shallow and deep bedrock, respectively.

The geometric mean of values of hydraulic conductivity, determined from piezometer tests in the tailings, was used for the entire Tailings Area. An estimate of the hydraulic conductivity for the underlying organic clay was used based on the material characteristics. Hydraulic conductivity of the shallow bedrock was originally assigned a value determined from the three piezometers in the area. This was later revised in order to obtain a calibration.

The water level elevations in the Tailings Area that exist are based on a local datum and, although attempts were made to translate the data to the geodetic datum that the model is based on, results were not completely satisfactory. Calibration was based on maintaining the groundwater levels below the ground surface in the Tailings Area and matching the flow measured and calculated at the east and west tailings dams walls. A reasonable match (half order of magnitude) was made between the model simulated flows in the surficial deposits and bedrock and both the measured and calculated flows for both dams walls.

The three remedial alternatives for the cover design identified above were modelled using an "extracted" grid from the larger model, which centred on the Tailings Area. Nine layers were included in each model including the five existing layers (i.e. crushed limestone, tailings, organic clay, shallow bedrock, and deep bedrock) plus the four new layers that were part of each remediation scenario (i.e. topsoil, silty clay loam, sand, and compacted clay).

Results of MODFLOW modelling were similar to the results of HELP modelling and indicate that the thicker the silty clay loam layer, the less water will percolate into the underlying sand drainage layer and the tailings. Reductions in percolation to the sand drainage layer, as a percentage of existing percolation through the tailings, are 61 percent, 83 percent and 85 percent for Alternatives 1, 2 and 3, respectively. The HELP model produced reductions of 70, 83 and 93 percent, respectively, for Alternatives 1, 2, and 3.

Groundwater collection wells were included in the Alternative 3 model below the dams walls, southwest and southeast of the Tailings Area. Modelling indicated that these wells were capable of producing 25.5 and 28.5 m^3/day for the southwest and southeast locations respectively. These wells may not necessarily need to be pumped at the maximum rate. As this water is to be directed to the equalization pond and, subsequently, to the ATP, the treatment system will need to be operated and maintained for the foreseeable future unless alternative treatment is adopted.

Alternative 2, when combined with groundwater collection downgradient of the tailings dams walls, has good potential to achieve the closure objectives for the Tailings Area. This modelling alternative, which is based on the recommended alternative for the Tailings Area, is projected to achieve the following:

- Reduce infiltration of rainfall into the tailings by 83 to 85 percent with similar reductions expected in contaminant input
- Collect and treat contaminated seepage and groundwater from the perimeter of the Tailings Area
- Further reductions may be achieved by enhancing the drainage from the sand and crushed limestone layers
- Diversion of unimpacted surface water runoff away from the Tailings Area will further reduce the potential for water quality impacts

It was recommended that pilot-scale groundwater extraction wells be installed and tested downgradient of the tailings dams walls to confirm the hydrogeologic conditions and expected flow rates to enable detailed design. These wells would be designed to enable conversion to full-scale operation subject to approvals. Groundwater conditions within the tailings should also be confirmed.

2.3 Environmental Assessment

The MOE is seeking the necessary approvals to undertake a project involving the long-term onsite management of historic wastes, contaminated soils, and low-level radioactive wastes (LLRW) currently located at and in the vicinity of the Deloro Mine Site. The MOE

understands that the licensing requirements for radioactive materials management under the *Nuclear Safety and Control Act* (NSCA) require that an Environmental Assessment (EA) under the *Canadian Environmental Assessment Act* (CEAA) be completed.

A report was prepared entitled *Deloro Mine Site Cleanup – Project Description, Final Report* (CH2M HILL, November 2002) to provide the appropriate federal authorities with a project description and related information to initiate the federal EA process under the CEAA. The project description provided relevant project site information and an overview of the anticipated construction, operation, remedial work, long-term monitoring, and consultation activities that will be undertaken as part of the cleanup of the Deloro Mine Site, including the offsite portion of Young's Creek.

The CNSC, in co-operation with the federal Department of Fisheries and Oceans Canada (DFO), subsequently prepared a document entitled *Environmental Assessment Guidelines (Scope of Project and Assessment), Environmental Assessment of the Deloro Mine Site Cleanup, Deloro, Ontario* (CNSC, October 2003). The purpose of the latter document is to provide guidance on the scope of a screening level EA to be conducted for the possession, management, and storage of nuclear substances at the Deloro Mine Site.

The CNSC notes in its EA Guidelines that a federal EA is required under the provisions of the CEAA. Under the CEAA, the scope of the project and the scope of the factors included in the assessment are determined by the Responsible Authority (RA) for the project. The RA for this project is the CNSC. The DFO has indicated that it is an RA for this project if an authorization under the *Fisheries Act* is required; however, if it is not required, the DFO will withdraw as an RA but will remain as a Federal Authority (FA) for the project. The EA Guidelines describe the basis for the conduct of the EA and focus the assessment on relevant issues and concerns. This document also provides specific direction to the proponent, the MOE, for the conduct and documentation of the technical EA study report, the responsibility for which will be delegated to them by the CNSC and DFO pursuant to subsection 17(1) of the CEAA. The EA Guidelines also provide a means of communicating the EA process to stakeholders.

CH2M HILL is currently preparing the EA study report on behalf of the MOE and it will draw upon this and other Closure Plans.

2.4 Assessment of Likely Cumulative Effects

According to the CEAA, an EA must include an assessment of cumulative effects. CH2M HILL is addressing the assessment of cumulative effects in the EA study report. Cumulative effects will include an assessment of the potential effects of the Deloro Mine Site project in combination with the effects of other projects. In order to have a cumulative effect, the works and activities associated with other projects must overlap with both the geographical area and time frame of the Deloro Mine Site cleanup project. The cumulative effects assessment will be focused on the consideration of potential effects to valued ecosystem components (VECs) and valued social components (VSCs). If a cumulative effect is likely, then mitigation measures are applied and the potential effect is reassessed. If residual effects will be identified after the reassessment, then their significance will also be determined.

2.5 Other Studies and Evaluations

All studies and evaluations that were utilized in this report can be found in the references section. Previous investigations completed in the Tailings Area are summarized in *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives, Final Report* (CH2M HILL, October 2003).

A study that related directly to the sourcing of some of the cover material for the Tailings Area is found in the memo entitled *Leaching Geochemistry of Young's Creek Clay Materials*, Draft Technical Memorandum (CH2M HILL, April 2004). It concluded that the lesser contaminated silty clay within onsite Young's Creek that will be removed are not suitable as fill material on the Tailings Area, due to the high risk of release of arsenic, cobalt, and copper from the Young's Creek material, resulting from water infiltration and oxidation of organic matter. Other concerns include scheduling challenges since materials may not be available when required, potential risk to wildlife, in particular burrowing animals, and the risk of organic material mixed with the clay that may compromise the geotechnical integrity of the clay cap when they decompose.

The geochemical response of the tailings to the proposed capping and long-term pore water drainage of the Tailings Area is discussed in a memo entitled *Geochemistry and Geochemical Modelling of the Tailings Area, Deloro Mine Cleanup Project*, Draft Technical Memorandum (June 2004). It concludes that, if there is drainage that is sufficiently contaminated, it will require treatment, and will either be trucked offsite to a wastewater treatment plant (if the ATP is decommissioned) or routed to a constructed natural treatment system. Also, potential wicking of porewater from the tailings will be interrupted by the existing crushed limestone cap, which will remain in place and be covered by the vegetated engineered cap. It will provide for a highly pervious zone that will allow for some limited atmospheric air to circulate to keep the tailings under oxidizing conditions. Therefore, it is considered that the proposed capping design of the Tailings Area is appropriate and will not result in adverse geochemical conditions.

3. Description of the Recommended Alternative

3.1 Site Security and Safety

The Deloro Mine Site and the Ontario Clean Water Agency (OCWA) compound are completely enclosed by a 7,606 m perimeter fence that was completed in March 2000 (Figure 3-1). The majority of the chain link perimeter fence was installed to a height of 2.13 m, including 0.30 m of barbed wire. Adjacent to Highway 7, the perimeter fence was installed to a height of 2.13 m to 2.44 m, without barbed wire to satisfy the Ministry of Transportation's Permit requirements.

There are seven points of entry to the site, mainly along the southern and western property boundaries, including five 9.0-m wide gates (includes one 9.0-m wide gate installed in 2003), one 6.0-m wide gate and one 1.2-m wide gate. The access gates will remain closed if not in use during the day and all gates will be closed and locked at the end of each working day to prevent public access to the site during remediation activities.

A group of three signs are affixed to the fence at distances varying between 50 m and 200 m, which read as follows:

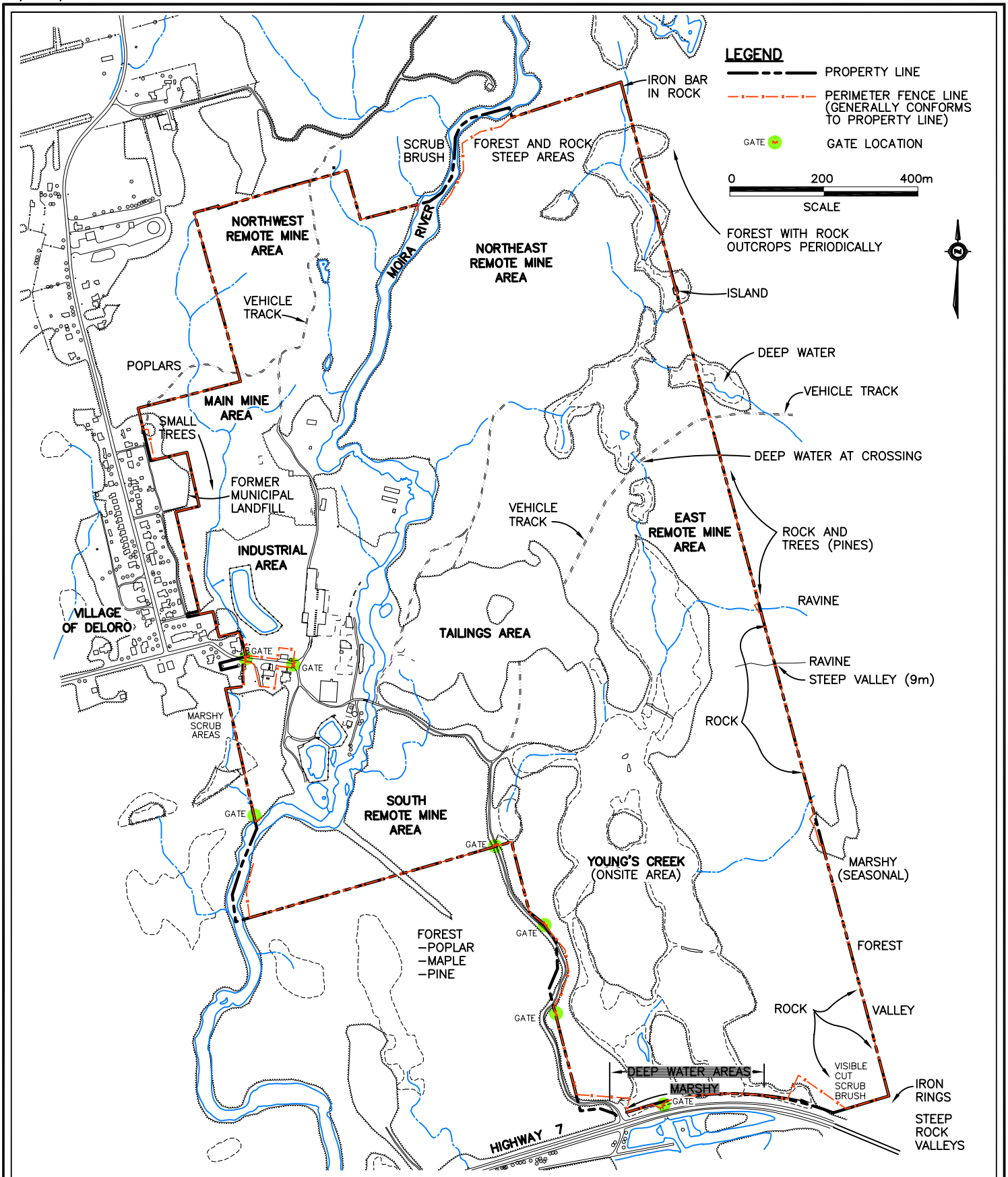
- *Danger, No Trespassing, Positively No Admittance* (25 cm by 36 cm).
- *Caution, Radiation Area, Radioactive Materials, Authorized Personnel Only* (25 cm by 36 cm).
- *Mine Hazard Area, Danger: Every person who alters, impairs, or destroys this notice, this fence or any rehabilitation work made in accordance with Part VIII of the Mining Act, is guilty of an offence and, upon conviction, is liable to a fine of not more than $30,000* (30 cm by 30 cm).

During the construction phase of the project, signs would be used to caution the public along Highway 7, in the Village of Deloro, and at site entrances. Signage may include "*Trucks Turning*" and other construction warning signs as well as "*Danger – Access By Permit Only*" at access gates. Additionally, flagmen may be needed along Highway 7 to control traffic when heavy machinery or large transport trucks enter or exit the highway.

The safety of workers and the community and environmental protection are discussed in Section 4.6 (Health Hazard Assessment) and Section 4.7 (Environmental and Community Health Protection Plan).

Access to the Tailings Area would either be through the main site access gate near the Arsenic Treatment Plant or from the access road off Highway 7. An assessment and reconstruction of the onsite bridge crossing the Moira River was recently completed as reported in CH2M HILL's *Deloro Mine Rehabilitation Project – Assessment and Reconstruction of Deloro Mine Site Bridge, Final Report* (CH2M HILL, June 2002). The key conclusions and recommendations of the report are as follows:

- The existing site bridge in 1998 was not suitable for the future construction activities.



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DELORO MINE SITE CLEANUP

FIGURE 3-1
PLAN OF PERIMETER FENCE

PROJECT No. 119548

- Although the site bridge was reconstructed in 2000, there will be loading limitations during site rehabilitation. The following equipment should not be permitted to cross the reconstructed site bridge:
  - A medium tracked excavator
  - A loaded articulated truck
  - A loaded four-axle truck
- If future contractors plan to use other types of trucks with different axle spacing and loadings, then further analysis should be carried out by a design professional.
- The need for construction equipment to cross the Moira River during site rehabilitation should be assessed after completion of the various Closure Plans to prevent exceedances of the reconstructed bridge's loading capacity.

3.2 Building Demolition

There are no buildings in the Tailings Area. Therefore, building demolition does not apply.

3.3 Waste Removal and Handling

This section describes the main wastes, as well as identifies the location and estimated quantities of the wastes in the Tailings Area. The removal, handling, transportation and conditioning, if required, of these wastes during the implementation of the Tailings Area rehabilitation alternative are also discussed.

3.3.1 Main Waste Types

A plan view of the Tailings Area is shown on Figure 3-2. Based on its location between the Moira River to the west and Young's Creek to the east, it is evident that measures to eliminate offsite contamination generated from the Tailings Area are a major concern. It is likely that the Tailings Area was the primary historical source of contamination of the Young's Creek floodplain sediments (CG&S, October 1998).

Previous investigations have indicated that contaminants were released from the Tailings Area by two processes: through leachate movement and by physical transport of fines (CH2M HILL, July 2002). Groundwater and pore water sampling in the Tailings Area indicates that the contaminants in the saturated tailings include arsenic, cobalt, copper, nickel, zinc, cadmium, molybdenum, and silver. Radiation fields were also detected underneath the crushed limestone cover of the Tailings Area (CG&S, June 1999). Based on loading calculations of arsenic, cobalt and copper to the Moira River and Young's Creek, it was determined that seepage from both the west and east sides of the Tailings Area contributes significant amounts of cobalt and copper to the Moira River and Young's Creek system on a site-wide basis (CH2M HILL, March 2002).

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23/JUNE/2004

INDUSTRIAL AREA

OVERLAND PIPING

EQUALIZATION POND

GARAGE

ARSENIC TREATMENT PLANT

MOIRA RIVER

YOUNG'S CREEK

NEW INTERCEPTOR DITCH CENTRELINES

DEPRESSIONS TO BE FILLEDTO PROMOTE SURFACE WATER RUNOFF

TAILINGS AREA

COLLECTION AND PUMPING SYSTEM

OVERLAND PIPING

EAST DAM AND SEEPAGE COLLECTION (CONCRETE WALL)

COMMON HEADER

WELL (TYPICAL)

COLLECTION AND PUMPING SYSTEM

SURFACE WATER DRAINAGE DITCHES

COMMON HEADER

WELL (TYPICAL)

WEST DAM AND SEEPAGE COLLECTION (ROCK WALL)

FERRIC ARSENATE SLUDGE LAGOON (ACTIVE)

FERRIC ARSENATE SLUDGE LAGOON (INACTIVE)

LEGEND

PROPERTY LINE

FENCE LINE

PIPING SYSTEM

1:100 YEAR FLOOD BOUNDARY

APPROXIMATE LIMITS OF TAILINGS AREA VEGETATED SOIL COVER

0 75 150m

SCALE

CH2MHILL

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-2: CONCEPTUAL PLAN OF THE PROPOSED TAILINGS AREA VEGETATED ENGINEERED SOIL COVER WITH INTERCEPTOR DITCH AND TREATMENT OF SEEPAGE AT WASTEWATER TREATMENT PLANT

PROJECT No. *119548*

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Although there is evidence that movement of fines has been a problem historically, the current movement of fines through the dam walls on either side of the Tailings Area appears to be insignificant based on their structural stability and the placement of limestone rip rap along the downstream side of the dam faces (CH2M HILL, July 2002). The placement of a crushed limestone cover by the MOE in 1987 over the Tailings Area has also reduced the potential for surface and wind erosion of fine tailings materials (Geocon, 1990). The limestone cover has also been shown to act as a shield against both radioactivity and airborne dust hazards (CG&S, June 1999).

Witteck Development Inc. (1986) conducted a metallurgical study of the red mud tailings to determine the composition and chemical characteristics of the red mud as originally discharged in the Tailings Area (i.e. prior to placement of the crushed limestone cover). The study revealed that the red mud solids are comprised of the elements shown in Table 3.1.

TABLE 3.1
APPROXIMATE ANALYSIS OF RED MUD (WITTECK, 1986)

Element	Percentage	Element	Percentage
As	4.29	Bi	0.030
Co	0.19	Ni	0.21
Fe	11.10	Ca[1]	14.8
Cu	0.59	SO_4[1]	38.4
Pb	0.019		

[1]Chemical Characterization Red Mud Tailings (Geocon, 1987)

These findings indicate that the predominant elements within the tailings are sulphate, calcium, and iron residues, in association with heavy metals. Witteck (1986) also found that the pH of the red mud pore water was low, with an indication that acidity was increasing over time. Increased acidity is known to increase the solubility of arsenic and other heavy metals in pore water and could potentially become a serious problem if leakage occurs to the surrounding water system (Geocon, 1987). Concerns relating to increased acidification and high concentrations of arsenic and metal ions in runoff diminished following placement of the crushed limestone cover in 1987. There is no conclusive evidence to suggest the limestone impacted the seepage pH; however, the pH of surface runoff water has changed from acidic to slightly alkaline (Geocon, 1990). The limestone cover has also provided a stable surface for light vehicular travel.

SRK (CH2M HILL, July 2002) examined the heavy metal content of the tailings solids beneath the limestone cover. This investigation consisted of borehole samples taken throughout the Tailings Area. It was found that arsenic, copper, nickel, and cobalt were significantly elevated above surface residential/parkland soil criteria for use in a potable groundwater situation (MOE, 1997). Results from these borehole samples are summarized in Table 3.2.

TABLE 3.2
CONTAMINANT CONCENTRATIONS IN RED, BROWN, AND YELLOW ORANGE/CREAM TAILINGS AS DETERMINED BY 1997 BOREHOLE SAMPLES TAKEN BY SRK

Chemical Parameter	Ranges in Concentrations (mg/kg)	Table A Soil Criteria Residential/Parkland[1] (mg/kg)
Arsenic	16,500 to 36,300	20
Copper	498 to 25,400	225
Nickel	211 to 4,450	150
Cobalt	180 to 1,130	40

[1]*Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997)

These results indicate that arsenic and copper are the primary contaminants within the tailings solids. The study showed evidence that the areas beneath the tailings materials were also contaminated by heavy metals. Organic material underlying the tailings contained arsenic, cobalt, copper, and nickel approaching or exceeding criteria. Arsenic and copper levels in the silt and fine sand samples beneath the tailings and above the bedrock layer also exceeded criteria (CH2M HILL, July 2002).

3.3.2 Miscellaneous Wastes

Two miscellaneous wastes are present adjacent to the two tailings dams walls. Waste rock that was likely imported from one or more of the onsite mine workings and miscellaneous fill that was likely pushed from the immediate area are piled up against the east and west tailings dams walls, respectively, to form berms (SRK, November 2003). These waste materials are presently covered by crushed limestone forming a substantial berm which is sloped at the angle of repose of the limestone material. These berms will be covered during the Tailings Area closure to help maintain the stability of the dams, as shown in Figures 3-3 and 3-4. The seepage and groundwater collection system is also shown in Figures 3-3 and 3-4.

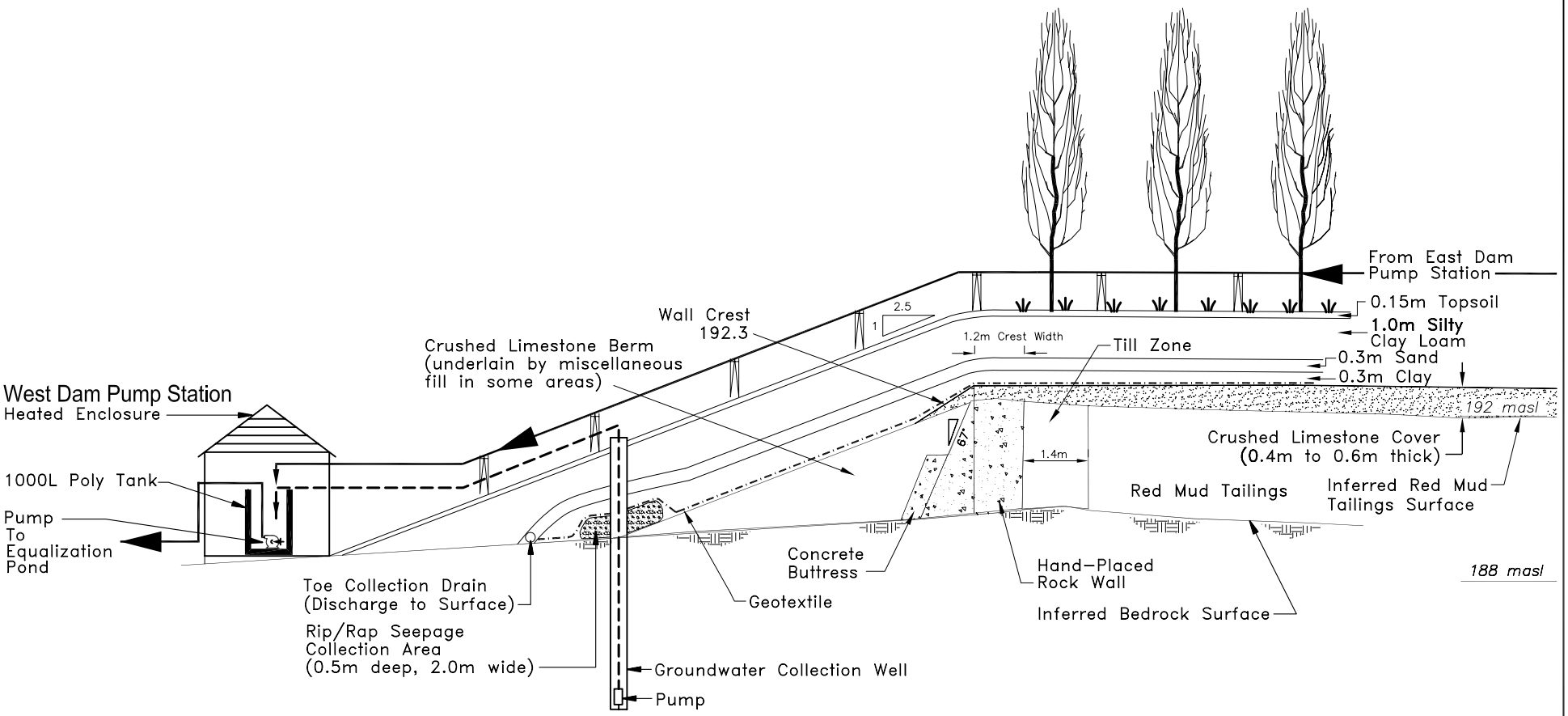
Currently no other miscellaneous wastes have been identified. If any miscellaneous solid, non-hazardous, or hazardous wastes are identified during the Tailings Area closure activities, they will be managed appropriately onsite.

3.3.3 Waste Inventory

The types of wastes identified in the Tailings Area were listed in Section 3.3.1 and 3.3.2. An inventory of the solid wastes is not applicable since there will be no excavation and transport of the tailings or the two identified miscellaneous wastes. The contaminated seepage and groundwater to be collected from groundwater wells, downgradient of the east and west tailings dams walls (see Figure 3-2), are expected to generate an average of 1,258 m^3/year (3.45 m^3/d) of flow to the ATP (CH2M HILL, October 2003). This flow rate is expected to decrease over time as the Tailings Area cap reduces the infiltration and resulting leachate production.

3.3.4 Waste Removal and Handling

As noted in Section 3.3.3, contaminated seepage and groundwater will be pumped from groundwater wells to the equalization pond for treatment at the onsite ATP. The borings from drilling the groundwater collection wells will be graded into the waste rock toe of the berm and covered during the capping process. No solid waste material is expected to be removed from the Tailings Area.



SECTION D

FIG. 3-2

0 1 2 3 4 5 METRES

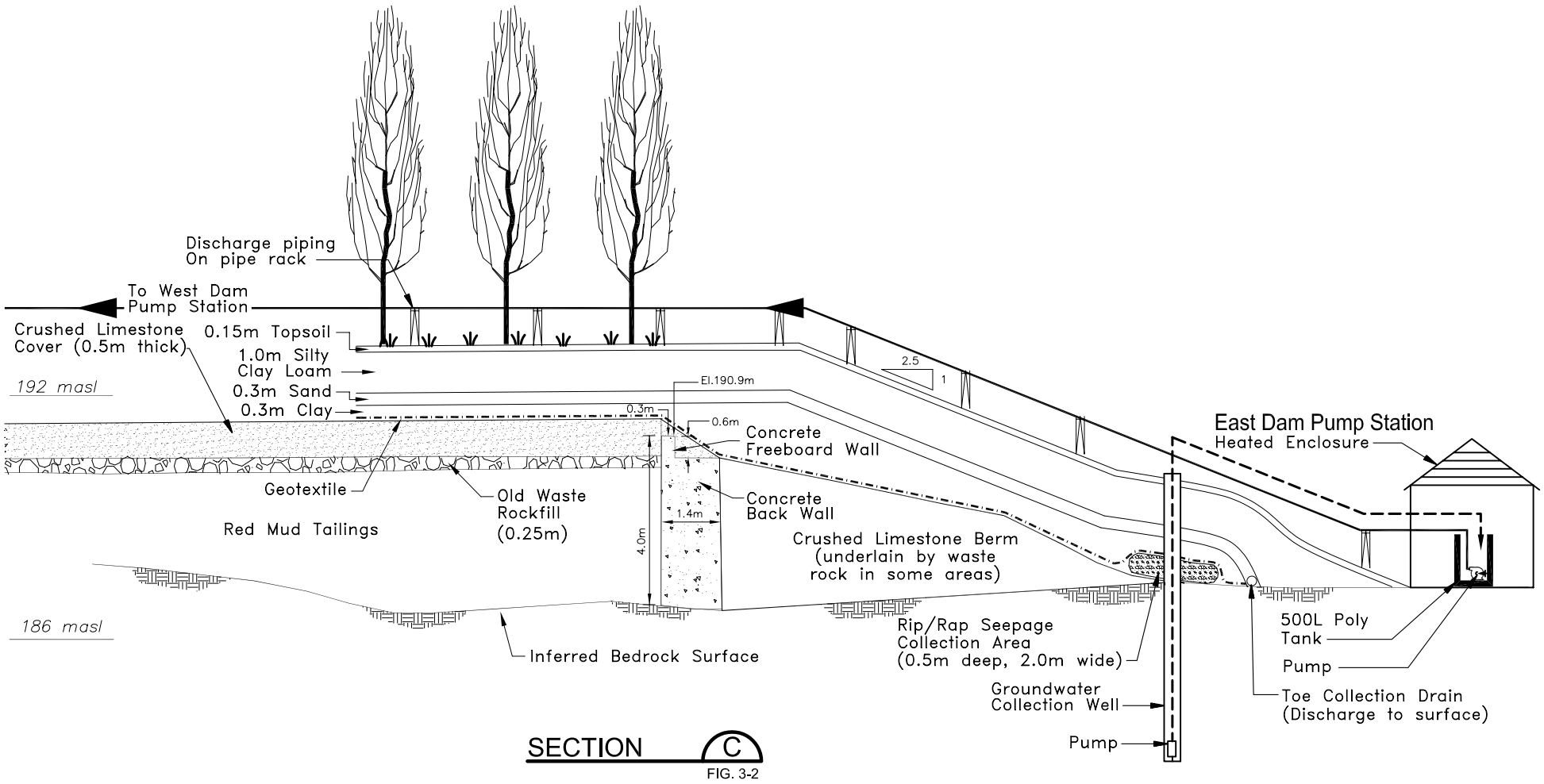
SCALE

CH2MHILL

PROJECT No. 119548

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-3
WEST DAM
COVER PLACEMENT



SECTION C

FIG. 3-2

0 1 2 3 4 5 METRES

SCALE

CH2MHILL

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-4
EAST DAM
COVER PLACEMENT

PROJECT No. 119548

3.3.5 Waste Transportation

Solid waste material from the Tailings Area will remain undisturbed or, in the case of the waste rock, miscellaneous fill, and well borings, will remain localized and require no transportation. Waste transport of the contaminated seepage and groundwater will be by way of pump and overland pipeline to the onsite equalization pond.

3.3.6 Waste Conditioning

At present, waste (tailings) materials identified in the Tailings Area will not require conditioning. Should the seepage from the tailings dams walls become acidic, the cover soil will be limed to increase the pH of percolating surface water. This contaminated water will continue to be transferred to the equalization pond and conditioning will be in the form of mixing and equalization with other contaminated water.

3.4 Waste Isolation and Containment

The comprehensive remediation alternative that is recommended for the Tailings Area is the construction of an engineered vegetated soil cover; construction of an interceptor ditch system; and the collection, transportation, and treatment of contaminated seepage and groundwater using the existing equalization pond and ATP.

The goals of this remediation alternative are to minimize:

- Contact between surface water runoff and the wastes
- Infiltration of precipitation into the wastes
- Subsequent contaminant leaching and migration to the Moira River and Young's Creek
- Offsite migration of contaminants by wind transport

3.4.1 Design Description, Plans, and Profiles

The preferred choice of the engineered soil cover consists of a layer of silty clay loam in combination with topsoil, sand, HDPE perforated collection piping, and compacted clay materials. A geotextile filter would separate the cover soils from the crushed limestone. Figures 3-5 and 3-6 present cross-sections of the Tailings Area showing the proposed cover. Note that depressions will require filling to promote surface water runoff, as shown in Figure 3-6. The topsoil provides the initial rooting medium for the hybrid poplar trees, while the silty clay loam and sand provide the necessary water storage capacity that will increase the effectiveness of the poplar trees. The HDPE perforated collection piping provides a conduit for conveying water that percolates to the sand layer either due to normal percolation below the tree root zone, or due to localized cap failure due to formation of fissures. The compacted clay layer functions as a low-permeability layer to minimize percolation of water into the underlying limestone cover and tailings (red mud). Based on the findings of the feasibility study (CH2M HILL, May 2002), the construction of a soil cover incorporating a 100-cm silty clay loam in addition to a 15-cm topsoil layer, a 30-cm sand drainage layer, and a 30-cm compacted clay base is predicted to be sufficient to achieve deep percolation reductions of about 83 percent above existing conditions. The soil/clay cover will extend down the face of the tailings dams walls to the toe of the crushed limestone berms and will function as a further buttress for the dams walls. Figures 3-3 and 3-4 present conceptual cross-section drawings of this proposed approach. Note that in the original Alternatives Report (CH2M HILL, October 2003), the silty clay loam layer was described as being either

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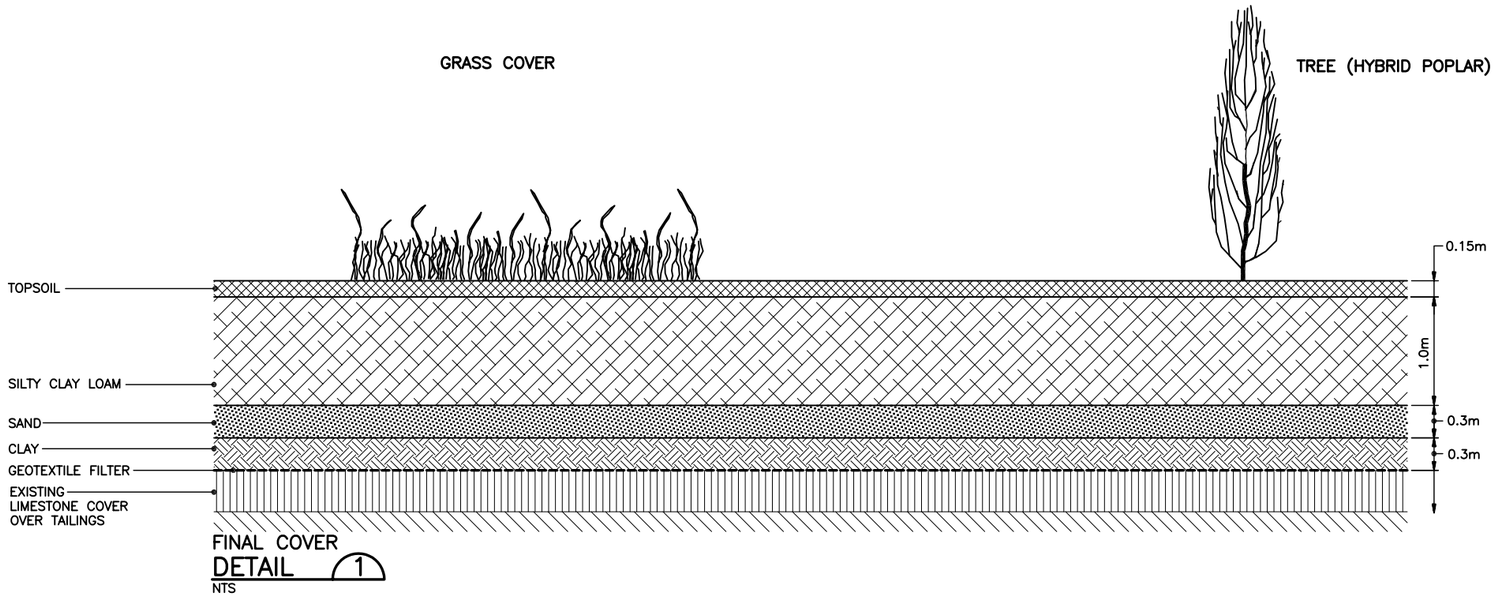
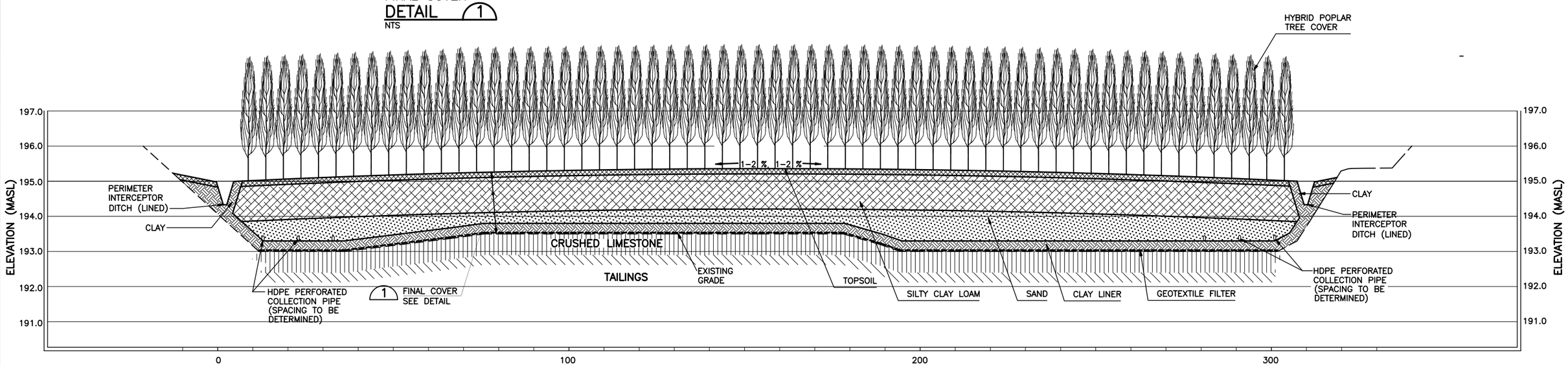


FINAL COVER
DETAIL 1
NTS



ENGINEERED SOIL COVER AND HYBRID POPLAR PLANTATION
SECTION A
10X VERTICAL EXAGERATION FIG.3–2

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PROJECT No. 119548

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-5
CONCEPTUAL CROSS-SECTION OF THE PROPOSED VEGETATED SOIL COVER

23/JUNE/2004

WEST

EAST

HYBRID POPLAR TREE COVER

TOPSOIL

SILTY CLAY LOAM

SAND

CLAY

EXISTING GRADE

CRUSHED LIMESTONE

GEOTEXTILE FILTER

TAILINGS

CLAY/TOPSOIL MIX

BEDROCK

SUBSURFACE DATA NOT DETERMINED

WEST DAM

DEPRESSION FILLED TO PROMOTE SURFACE WATER RUNOFF

EAST DAM

TAILINGS

CRUSHED LIMESTONE

BEDROCK

CLAY/TOPSOIL MIX

SUBSURFACE DATA NOT DETERMINED

ROCK FRAGMENTS

ELEVATION (masl)

199.0
198.0
197.0
196.0
195.0
194.0
193.0
192.0
191.0
190.0
189.0
188.0
187.0
186.0
185.0

0+000.0
0+100.0
0+200.0
0+300.0
0+400.0
0+500.0

HORIZONTAL DISTANCE (m)

SECTION B

FIG. 3–2

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PROJECT No. 119548

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-6
CONCEPTUAL CROSS-SECTION OF THE PROPOSED VEGETATED SOIL COVER

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100 cm or 150 cm in depth and was costed for the 150 cm depth. Deep percolation reductions of 83 percent and 93 percent for the 100 cm and 150 cm depth silty clay loam layers respectively represented a minor change in overall reduction. Also, the sand layer underlain by the compacted clay liner is expected to transmit lateral flow away from the Tailings Area, thus reducing percolation to up to 100 percent (CH2M HILL, May 2002).

An irrigation system will be installed to allow watering of the hybrid poplar tree plantation for a period of approximately three years.

3.4.2 Material Sourcing and Haulage Routes

Sources of offsite clay, sand and other materials are currently being identified and verified by CH2M HILL. This information will be completed during the design phase following acceptance of the Closure Plan. The types of materials, quantities required, and purpose are summarized in Table 3.3.

TABLE 3.3
SUMMARY OF PROPOSED IMPORTED MATERIAL REQUIREMENTS

Material Description	Estimated Quantity (m^3)	Purpose
Rip rap (500 mm)	8,132	Ditch erosion control
50 mm crushed stone	1,325	Washpad and temporary road construction
Clay (Hydraulic Conductivity $<10^{-7}$ cm/s)	25,800	Soil cover liner
Coarse to medium sand	28,380	Soil cover drainage layer
Silty clay loam	129,000	Soil cover rooting zone
Topsoil	12,900	Soil cover planting and rooting zone

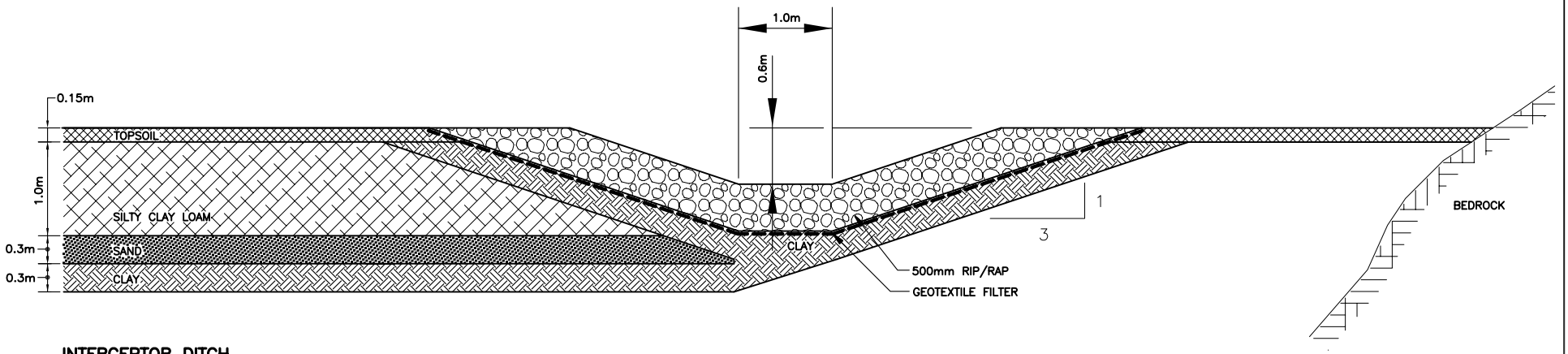
3.5 Water Management

3.5.1 Surface Water and Stormwater Management

Although the use of an engineered soil cover and hybrid poplar plantation is predicted to be effective in reducing the infiltration and deep percolation of water, an interceptor ditch is also recommended to achieve a greater level of water inflow reduction. The advantages of an interceptor ditch include a reduction of the surface water flow into the Tailings Area and an expected reduction of the influx of contaminants into the Moira River and Young's Creek.

An effective interceptor ditch could be constructed along the north and east side of the Tailings Area, where reduction in the effective catchment area can be achieved. The unimpacted surface water runoff (i.e. stormwater) would be diverted to Young's Creek via the interceptor ditch. Surface water runoff from the capped tailings will be diverted by ditches to low-lying areas south of the Tailings Area. Figure 3-2 presents the conceptual approach to surface and stormwater management. Figure 3-7 presents a cross-section of the proposed stormwater interceptor ditch.

During the construction of the engineered soil cover, any existing depressions will be filled in to promote runoff. Final surface grading of the Tailings Area will be designed to promote surface water runoff.



INTERCEPTOR DITCH
SECTION E
NTS FIG. 3–2

CH2MHILL

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-7
INTERCEPTOR DITCH CROSS-SECTION

PROJECT No. 119548

3.5.2 Seepage and Groundwater Management and Treatment

A downgradient collection and pumping system will be installed to capture contaminated seepage beneath the east and west tailings dams walls and associated contaminated groundwater. The contaminated water will be conveyed by overland piping to the equalization pond for treatment at the existing onsite ATP. Since the existing ATP can satisfactorily remove dissolved cobalt from the onsite contaminated groundwater, the increase in capital and OMM costs associated with the installation of a collection and pumping system is considered low compared to the load reduction potential of cobalt to the environment.

All seepage and groundwater conveyance to the equalization pond will be surface mounted, heat traced, and metal clad to reduce the potential for erosion in the unlikely event of a pipe leak. Above-ground piping will also provide for a good visual check for leakage.

3.5.3 Residue and Sludge Management

Over time, there may be a buildup of residue and/or sludge in the groundwater collection wells. Long-term OMM will determine if this will occur and to what extent. If it does occur, there will be a requirement for regular solids removal and transfer to a hazardous or non-hazardous offsite landfill, depending on the contaminant levels and leachability of the solids. CH2M HILL is evaluating the sludge disposal options for the rehabilitated site and the onsite disposal of this material may be a possibility depending on the outcome of the review process.

3.6 Mine Workings, Crown Pillars, and Surface Workings

There are no mine workings, crown pillars, or surface workings associated with the rehabilitation of the Tailings Area.

3.7 Final Site Grading

The entire Tailings Area surface will be altered through capping and grading. The Tailings Area will be graded to reduce stormwater infiltration and promote runoff. Added fill material will be required in some low-lying areas to reduce potential ponding and promote surface water runoff.

3.8 Site Rehabilitation and Revegetation

Following the completion of the site rehabilitation measures (i.e. cover/cap placement, stormwater interceptor ditch construction, and site grading), the Tailings Area will be landscaped to suit the intended final use and seeded with a mixture of grasses in order to stabilize the surface and limit erosion until the hybrid poplar tree plantation is firmly established.

3.8.1 Riverbank and Water Courses

No impact is expected to the Moira River and the Young's Creek riverbanks and watercourses since the majority of the construction activities proposed for the Tailings Area are distant and above the 100-year flood boundary (CG&S, November 1998). Work in the vicinity of the east and west tailings dams walls may require some surface water protection measures (see Section 3.8.4).

3.8.2 Waste Removal Areas

The tailings will be left in place and removal of this material will not be required. Installation of the groundwater collection wells may require the removal of some of the historic tailings material, downgradient of the tailings dams walls. This material will be placed onto the tailings prior to constructing the engineered soil cover or isolated in the secure containment cell in the Young's Creek Area.

3.8.3 Waste Isolation Areas

Since no material will be removed from the Tailings Area it will, in effect, become a large waste isolation area. Stormwater and surface water runoff will be controlled by surface grading and the interceptor ditch. Any precipitation or stormwater that does not run off or is not evapotranspired by the vegetated soil cover will be intercepted and removed by the sand layer.

3.8.4 Temporary Works

Temporary works for the excavation and construction efforts in the Tailings Area include the following:

- Silt fencing along the edge of watercourses including along and upstream of the Moira River and Young's Creek
- Dam and diversion measures for upstream stormwater north of the Tailings Area, to allow excavation and construction of the interceptor ditch
- Road improvements for two-way truck traffic to and from the Tailings Area along the southern perimeter
- Temporary road access for areas that are currently not accessible and which require excavation, filling, and/or grading
- Temporary road access measures to distribute the load of haul trucks on the tailings surface
- Dust controls for roads that will be used by haul trucks and other construction equipment
- Erosion protection for newly excavated and/or placed soils
- Staging and waste conditioning areas (if required)
- Personal protective equipment (PPE) decontamination and change facilities
- Decontamination/control stations
- Washpad for equipment and trucks
- Truck tarping stations
- Equipment laydown areas
- Equipment storage containers
- Office trailers

4. Implementation Plan

4.1 Identification of Work Packages

The work packages identified for the Tailings Area rehabilitation program are listed in Table 4.1.

TABLE 4.1
IDENTIFICATION OF WORK PACKAGES

Package I.D.	Work Package Description
TA-WP#1	Contractor set-up, access routes preparation, construction of washpad and mobile washer, installation of surface water control items, and temporary road construction to Tailings Area.
	Clearing and grubbing the perimeter of the Tailings Area, especially along the northern edge to allow for placement of and grading for the interceptor ditch. Clearing and grubbing to remove trees from the tailings surface and from the rock outcroppings within the Tailings Area.
TA-WP#2	Placement of the rip rap and geotextile at the toe of the tailings dams walls. Placement of the geotextile along the slope of the crushed limestone berm portion of the dams walls and on the crushed limestone covering the tailings.
TA-WP#3a	Capping the tailings surface and the dam slopes to the toe of the dams walls with 0.3 m clay, 0.3 m sand, 1.0 m silty clay loam, and 0.15 m topsoil, then seeding with grass.
	Construction of the interceptor ditch for the north and east portion of the Tailings Area and the drainage ditches at the south portion of the Tailings Area that will occur towards the end of the earthworks and prior to planting the poplar plantation since it will be incorporated into the final cover.
TA-WP#3b	Installation of hybrid poplar trees (cuttings or bareroot) and the irrigation system.
TA-WP#4	Installation of groundwater collection wells, pumps, and power supply to the pumps. Construction of heated enclosures and overland piping from the Tailings Area to the equalization pond.

4.2 Sequencing of Work Packages

In general, the work packages would be completed in the order listed in Table 4.1. However, the opportunity exists for sub-components of the work packages to be completed concurrently with the closure of other site areas. This will be considered further in the development of the integrated site-wide cleanup plan.

Studies have determined that the marginally contaminated material from Young's Creek cannot be used as cover material in the Tailings Area without creating an adverse impact, as described in *Leaching Geochemistry of Young's Creek Clay Materials*, Draft Technical Memorandum (CH2M HILL, April 2004).

The main sequencing for the work proposed for the Tailings Area relates to the collection and treatment component. The installation of piping across the Industrial Area to convey the contaminated seepage and groundwater to the equalization pond will need to be delayed until the Industrial Area capping is completed since the piping will travel across this area on an overhead pipe rack.

4.3 Anticipated Construction Impacts and Mitigation Measures

Anticipated construction impacts and mitigation measures are summarized in Table 4.2.

TABLE 4.2
ANTICIPATED CONSTRUCTION IMPACTS AND MITIGATION MEASURES

Construction Impacts	Mitigation Measures
Clearing and grubbing of trees and shrubs during site preparation	Altered areas will be revegetated with poplar plantation and grasses.
Suspended particulates in air from heavy equipment/vehicles adversely affecting air quality	Dust suppression methods will be utilized on an “as needed” basis.
Vegetation removal for temporary road construction or existing road upgrades to accommodate heavy vehicles	Roads not required for the future OMM of the site will be excavated, backfilled with appropriate material and revegetated to blend in with existing cover/cap requirements.
Suspended sediment in surface water	Diversion dams/trenches, and geotextile silt fencing will be used to isolate surface water flows from active excavation areas. Sediment settling/retention ponds may be required.
Rock blasting during trench and ditch installation (if required)	Performed in accordance with the applicable regulations with blasting mats.

4.4 Implementation Schedule

An implementation schedule for the four work packages is presented in Table 4.3.

TABLE 4.3
IMPLEMENTATION SCHEDULE OF WORK PACKAGES

Package I.D.	Work Package Implementation Schedule
TA-WP#1	Contractor set-up, prepare access routes, construct washpad/mobile washer, surface water control installation, construct temporary road to Tailings Area, and clear and grub in Year 1.
TA-WP#2	Placement of rip rap and geotextile in Year 1.
TA-WP#3a	Install cap (sand, HDPE perforated collection pipe, soil, clay, grass cover), interceptor ditch and drainage ditches in Year 1 and maintain during the following three years to help minimize tree mortality.
TA-WP#3b	Plant poplar plantation and install irrigation equipment in Year 2.
TA-WP#4	Drill groundwater collection wells in Year 2, install electrical service, and pumps and construct heated enclosure. Install overland piping in subsequent year(s) to coincide with completion of activities in other areas that piping installation is dependent on (i.e. Industrial Area).

Figure 4-1 illustrates the proposed project schedule.

Figure 4-1
Proposed Project Schedule

Deloro Mine Site Cleanup, Tailings Area Rehabilitation Closure Plan Implementation

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Ontario

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		Year 1				Year 2			
Work Package ID Number	**Description**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
	Project Initiation								
TA-WP#1	**Site Preparation**								
TA-WP#2	**Rip Rap and Geotextile Placement**								
TA-WP#3a	**Cap Installation (clay, sand, HDPE perforated collection pipe, fill material, and topsoil) and Grass Planting**								
	Interceptor Ditch Installation								
	Drainage Ditches Installation								
TA-WP#3b	**Irrigation System Installation**								
	Poplar Plantation Installation								
TA-WP#4	**Seepage/Groundwater Collection System and Overland Piping Installation**								

4.5 Cost Opinion for Each Work Package

The costs required to implement the recommended rehabilitation alternative for the Tailings Area of the Deloro site were developed previously in the report *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives, Final Report* (CH2M HILL, October 2003). The costing developed for the above report has been used to assign a cost estimate for each of the work packages as shown in Table 4.1. Dam stability assessment work completed since that time has resulted in an increase in area of approximately 6,000 m^2 to be covered along the slope of the tailings dams walls (8 percent increase).

The updated costs in Table 4.4 take into consideration the following information and data which has become available since the alternatives report was finalized in October 2003.

- It will be necessary to increase the Tailings Area cap by approximately 0.6 ha in order to follow the crushed limestone berms to the adjacent bedrock surface.
- The depth of the silty clay loam layer will be reduced to 1.0 m from 1.5 m (see Section 3.4.1).
- Suitable clay has not been confirmed locally. It has been conservatively assumed that all clay (i.e. 100 percent) will have to be imported from a non-local source, compared to 50 percent as was indicated in the Tailings Area alternatives report.

TABLE 4.4
ESTIMATED COSTS FOR IMPLEMENTING RECOMMENDED ALTERNATIVE

Work Package Identification #	Description	Estimated Cost* (2004 dollars)
Capital Cost Items		
TA-WP#1	Site Preparation	$283,500
TA-WP#2	Placement of Rip Rap and Geotextile	$313,600
TA-WP#3a and 3b	Installation of Engineered Cap (clay, sand, HDPE perforated collection pipe, silty loam, topsoil, and grass) and Interceptor and Drainage Ditches; Installation of Poplar Plantation and Irrigation System	$6,694,100
TA-WP#4	Tailings Seepage and Groundwater Pumping and Piping System	$216,000
	Total Capital Costs	**$7,507,200**
OMM Cost Items (Annual [Weighted])		
TA-OMM#1	OMM Program	$88,020
	Total Annual (Weighted) OMM Costs	**$88,020**
Net Present Value OMM Costs		**$1,293,200****
Net Present Value of Capital and OMM Costs		**$8,800,400**

*All costs have been developed using 2004 pricing and do not include an escalation factor.

**Net Present Value (NPV) of Annual OMM Costs using an effective interest rate of 5 percent, and a 20-year planning horizon.

The net present value (NPV) costs presented above are the sum of the capital cost and the net present value of the OMM costs. The annual OMM costs have been transformed to a net present value assuming an effective interest rate of 5 percent and a planning horizon of 20

years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs will be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

The total estimated capital cost to rehabilitate the Tailings Area is $7,507,200 in 2004 dollars with annual (weighted) OMM costs of $88,020. The NPV of this remediation work, assuming an effective interest of 5 percent and a planning horizon of 20 years is $8,800,400.

The costs provided in Table 4.4 have been revised to account for the increased area of capping. The capital costs presented in Table 4.4 include overhead and remote location costs, the federal Goods and Services Tax (GST), a 15 percent contingency for the capital costs, a 5 percent contingency for the OMM costs, and the cost of insurance and various construction bonds associated with the work. The costs presented are expected to have accuracy on the order of +/-25 percent. A breakdown of the estimated costs is provided in Appendix A. The major assumptions used in making this cost estimate are also provided in Appendix A. The costing in Appendix A has been completed at the preliminary design level and should be considered as a "cost opinion" to assist in budgeting. An appropriate allowance should be included in any budget planning to account for cost escalation factors for work after 2004. Costs can further be refined once the recommended alternative has been accepted and the detailed design and approach have been finalized.

A cost estimate for replacement monitoring wells, associated with post-remediation groundwater monitoring, is not included in Table 4.4, since the number of groundwater monitoring locations will require further evaluation.

4.6 Health Hazard Assessment

A document entitled *Deloro Mine Rehabilitation Project – General Health and Safety Plan (GHASP), Final Report* (CH2M HILL, January 2002) has been developed to identify the main hazards and to provide a basis for the health and safety protocols.

The GHASP identifies the following health hazards associated with the Deloro Mine Site, that could be encountered while undertaking site inspections, site investigations, and remedial cleanup:

- Arsenic and arsenic compounds, other metals and silica
- Radiological hazards
- Heat and cold stress
- Buried utilities
- General physical (safety) hazards
- Biological hazards
- Chemicals existing at or brought onto site

The GHASP outlines and describes appropriate procedures and protocols to effectively deal with the above hazards associated with the Deloro Mine Site. The GHASP addresses: hazard evaluation and control procedures and protocols (including action levels), personal protective equipment to be used, air monitoring protocols and specifications, decontamination procedures and protocols, spill containment procedures, confined space entry procedures, emergency response plan, and emergency contacts.

Addenda will be added to the GHASP to address hazards associated with specific work packages identified in this and the other three Closure Plans.

The health hazard to workers will be greatest during construction of the engineered cover due to possible sinking into the soft underlying tailings. As previously noted, confirmation that heavy construction equipment can be supported on the Tailings Area will be evaluated during the detailed design stage. A hazard potential is also associated with the drilling of the groundwater collection wells at the east and west tailings dams walls due to exposure to buried tailings materials that may be radioactive (see below). Pump startup may generate a health hazard due to leaks in the piping or pumps that could spray onto adjacent workers.

Radiological hazards result from radioactive slag, some tailings-like material in the Industrial Area, and sediments in the onsite Young's Creek Area contaminated by radium and uranium tailings eroded from the Tailings Area. The slag represents an external hazard from radiation fields, whereas the tailings-like material and sediments represent both external hazards due to radiation fields and internal hazards from potential ingestion and/or inhalation during the handling activities. Although ambient radiation fields in most of the work areas are expected to be below 1 μSv/h, standard radiation protection procedures as described in the GHASP will be employed to minimize doses to workers during the various remediation activities. Routine radiation field monitoring will be used to identify those areas in which radiation protection procedures must be implemented. Contamination control procedures will also be implemented as described in the GHASP. Decontamination procedures are outlined in Section 4.7.4 of this Closure Plan.

4.7 Environmental and Community Health Protection Plan

Potential receptors that could be affected by of the cleanup of the Deloro Mine Site include workers involved in the site cleanup, residents in the Village of Deloro, residents and cottagers along the Moira River downstream of the site and vehicular traffic along Highway 7 near Young's Creek (in the case of impacted materials to be transported onsite from offsite Young's Creeks across Highway 7). The following Environmental and Community Health Protection Plan (ECHPP) identifies potential risks associated with the cleanup of the Deloro site and recommends appropriate mitigation measures. Protection of workers involved in the site cleanup was addressed in Section 4.6.

The disturbance of potentially contaminated materials during remedial activities and the possible loss of contaminants from the work area depend to a high degree on the remedial methods and related physical activities undertaken during site rehabilitation. Since the transport of contaminants is most easily controlled at the source, the remedial activities selected for the site have been chosen based on the ability to minimize and control the disturbance, spread and loss of contaminants from the work area. Additional actions can be taken to further limit the spread and loss of contaminants from the work area and potentially offsite. These include measures to control dust, noise, odours, surface water runoff, surface water run-on, and erosion, as well as the use of appropriate equipment and personnel decontamination procedures. Each of these measures, which are discussed briefly below, will be undertaken prior to and during implementation of the remedial activities. Odour control is not discussed since it is not expected to be of concern during implementation of remedial activities at the Deloro site.

It should be noted that this overview provides some of the key aspects associated with the mitigation and monitoring of potential offsite impacts resulting from remedial activities at the Deloro site. The finalized details and procedures will be included in the contract documents and specifications associated with the rehabilitation of the Deloro site and the execution plans proposed by the remedial contractors who are selected to complete the cleanup work.

4.7.1 Dust Control and Air Monitoring

Effective dust control at sites undergoing remediation is best addressed via the development, establishment, implementation and enforcement of a fugitive particulate emission control program. The development and implementation of such a program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. The fugitive particulate emission control program includes a description of the procedures relating to the handling of materials, air monitoring and dust control, and is documented in the contractor's execution plan for the site remedial activities. The remedial contractor is required to take all precautions necessary to minimize and control the generation of dust and under no circumstances will unacceptable levels of dust be permitted to be generated and/or transported offsite.

Key aspects of a fugitive particulate emission control program include:

- Carrying out remedial activities that involve disturbance of material, such as excavation, during good weather conditions in order to minimize the loss of materials by wind.
- Movement of materials directly to their designated location, rather than handling several times, in order to minimize the generation of dust (i.e. multiple handling tends to break materials into smaller and smaller pieces which are more likely to be entrained by wind).
- Ensuring adequate equipment and personnel are available at the site at all times to immediately clean up any spilled material, whether it be of a small or large amount.
- An inspection program to monitor the condition of onsite and offsite roads, materials piles, vehicles, etc.
- The use of tarps to cover materials which are likely to generate dust.
- The use of dust suppressants to control dust associated with roadways, work areas, stockpiles and other possible sources. Materials used to assist in dust suppression might include water, calcium chloride or latex binders. The frequency of application of dust suppressants is generally on an as-needed basis.
- Regrading of unpaved roads, as required, to keep silt content below 10 percent, and the sweeping of paved roads.
- The use of tarps on trucks used to transport materials onsite and offsite.
- In the case of the Deloro site cleanup, air monitoring both upwind and downwind of the site will be carried out in order to confirm that dust control measures are effective, and to ensure that any potential offsite air quality impacts caused by remedial operations are minimized. Monitoring should be carried out for dustfall and total suspended particulate matter (TSP). Monitoring for arsenic and other selected metals should also be considered. Although in the handling of radioactive tailings, radioactive contaminants

may become airborne, the expected levels will be considerably less restrictive than those for arsenic at similar TSP concentrations.

- The frequency of monitoring and location of monitoring stations at the Deloro site will be determined following the development of the final integrated cleanup plan, and the review of the contractor's execution plan, the proposed remedial activities and meteorological conditions. Typically, TSP is measured using standard high-volume samplers and a daily (24-hour) average determined. Depending on the size of the site, samplers are typically located at four upwind/downwind perimeter sites during each work day. Their location is subject to change based on the location of remedial activities, but they are generally placed at the furthest possible distance downwind of the site within the property line. Standard dustfall jars are used to obtain dustfall measurements, which are typically determined based on a 30-day integrated measurement of dustfall loadings at four perimeter locations.
- Meteorological measurements (wind speed and direction) may also be required to be carried out in conjunction with the air monitoring program. Typically, hourly and daily average wind speed and direction at one localized site could be required during site activities.
- The MOE Ambient Air Quality Criteria (AAQC) for dustfall is 7 g/m^2 (30-day AAQC) and for TSP is 120 $\mu g/m^3$ (24-hr AAQC). The AAQC for TSP and dustfall were determined with nuisance effects being the limiting factor. Health effects are not a concern until TSP levels are several times higher than defined by the AAQC, unless elevated concentrations of arsenic and/or other metals are present in the dust. Levels in excess of these criteria, on the basis of property line monitoring results, are considered unacceptable. In instances where background or upwind concentrations exceed these criteria, additional contribution to the parameter is also normally considered unacceptable.
- Monitoring of ambient air quality prior to initiation of remedial activities at the Deloro site is recommended and should be carried out on several occasions and under a variety of conditions in order to establish background air quality both onsite and offsite.

4.7.2 Noise Control

While noise is expected to be generated at the Deloro site during cleanup as a result of mobile sources such as truck and vehicular traffic, as well as equipment sources such as excavators, bulldozers, compactors, generators, pumps and air compressors, conformation with regulatory requirements is not expected to be a major problem. The development and implementation of a noise monitoring and control program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant prior to initiation of any site work. The contractor is usually required to provide written details of the noise monitoring and control program in the execution plan to ensure that local requirements are met.

Typical aspects of a noise monitoring and control program include:

- The contractor will be required to take all precautions necessary to minimize noise and under no circumstances will unacceptable levels of noise be permitted to impact offsite residents/property owners.

- The contractor is to conduct all work using appropriate construction methods and equipment so that noise emanating from the site remains at acceptable levels.
- The contractor is required to obtain approval from the owner and/or consultant prior to conducting any site activities between the hours of 6:00 p.m. and 7:00 a.m.
- The contractor will be required to undertake noise monitoring if deemed necessary.
- MOE noise guidelines for landfill operations suggest that a criterion of 50 dBA during the hours of 7:00 a.m. and 7:00 p.m. should be established for the closest residential location. A similar guideline may be suitable for the cleanup activities at the Deloro site.

4.7.3 Surface Water Protection

The control of surface water is required in order to minimize the contact of water with potentially contaminated materials and thus reduce the generation of contaminated water. This can be achieved though the control of surface water runoff from the work area, as well as the control of surface water run-on into the work area. Surface water is also required to be controlled in order to minimize erosion and prevent the offsite transport of potentially contaminated water and sediment to Young's Creek and the Moira River. Specific details relating to the control of surface water will be dependent on the final engineering designs for the cleanup of the site.

The development and implementation of a work area surface water control program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. Generally, the remedial contractor is required to take all precautions necessary to minimize the generation of sediment and potentially contaminated surface water and may be required to collect and treat any such water.

Key aspects of a work area surface water control program include:

- The use of geotextile silt fencing, sand bags and/or straw bales to reduce sediment transport.
- The construction of surface water diversions, comprised of swales and sumps or clay berms, to re-direct and/or collect surface water runoff and run-on.
- The collection and treatment of all potentially contaminated water, including water used to decontaminate equipment, surface water and water generated from the dewatering of excavations.
- In the case of the Deloro site cleanup, surface runoff characteristics (i.e. quantity, quality and direction of flow) of the site should be addressed prior to initiation of remedial activities. Additionally, an assessment of the quality of water in existing site drainage ditches and channels, including those that result in both run-on and runoff, standing water and natural water (i.e. any adjacent natural streams, wetland areas, and the Moira River) should be undertaken prior to remedial activities (if not addressed through current site monitoring). The water quality assessment should include the sampling and analysis of water for total suspended solids, arsenic, and metals.
- Once a decision on the activities planned for the Deloro site is made, a site-wide surface water quality monitoring program should be developed for implementation during the cleanup.

4.7.4 Decontamination Procedures

In order to prevent the transfer of contaminants from the work area, all equipment, materials, and supplies that come into contact with potentially contaminated materials must be decontaminated prior to removal from the work area. The development and implementation of equipment decontamination procedures is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. The remedial contractor is required to take all precautions necessary to minimize the transfer of contaminated materials from the work area. Under no circumstances is the transfer of non-decontaminated equipment and materials from the work area permitted.

The key aspects of a decontamination program include:

- Decontamination of equipment and materials that have come into contact with potentially contaminated materials, completed by the contractor prior to the removal of equipment and materials from the work area.
- Equipment decontamination using water or steam facilities to decontaminate tracks, sprockets, tires, axles, buckets, and trailers used in the transport of materials.

In general, the need for extensive decontamination during remediation of the Tailings Area is not envisaged since the tailings will not be disturbed.

4.7.5 Emergency Response and Preparedness

CH2M HILL will develop a site-specific emergency procedures plan including requirements and information relating to emergency contacts, directions to the nearest hospital, spill and fire control, emergency communications, emergency response such as for a spill or fire, medical emergency, notification, and reporting. All site contractors will be expected to be familiar with and implement the site-specific emergency procedures plan as required. Much of this information is already contained in the GHASP (CH2M HILL, January 2002).

4.7.6 Associated Considerations and Activities

Several issues associated with the mitigation of offsite impacts include:

- CH2M HILL will develop a site Transportation and Emergency Response Plan (TERP) to outline the procedures and protocols for addressing vehicular accidents and spills of hazardous and non-hazardous materials. Procedural controls will limit the speed of vehicles and determine safe routes.
- The development and implementation of specific work practices associated with contamination, decontamination, and clean work zones.
- In addition to the existing perimeter fencing, the development and implementation of a site security plan including aspects such as additional fencing of work areas, warning/caution signs, security patrols, control of site staff and visitors, etc.
- The use of a qualified environmental contractor who is experienced in similar types of projects, has a good safety and environmental record, and whose employees are experienced and qualified.

4.8 Other Operational Procedures

Other operational procedures are associated with the operation of the ATP in the Industrial Area. As detailed in Section 3, contaminated seepage and groundwater associated with the Tailings Area will be pumped to the equalization pond for treatment at the onsite ATP. The operational procedures associated with the ATP are contained in the Industrial Area Closure Plan.

5. Operation and Maintenance Requirements

Operation and maintenance requirements are discussed in this section and monitoring requirements are discussed in Section 6. A detailed OMM plan should be established for the Tailings Area facilities following implementation.

OMM efforts under this Closure Plan relate to the ongoing operation of the seepage and groundwater collection and conveyance system, and the maintenance of the hybrid poplar trees. Other maintenance efforts will include periodic maintenance of the engineered soil cap, the stormwater interceptor ditch, and the surface water drainage ditches.

5.1 Seepage and Groundwater Collection and Conveyance System

OMM efforts under the recommended alternative will be associated primarily with the ongoing operation of the seepage and groundwater collection and conveyance system. Routine inspection and maintenance of the pumps will be necessary. The overland piping system may require periodic flushing and cleaning. Pipe integrity testing by regular pressure testing will be required. Regular pump maintenance, such as routine seals replacement, will be as specified by the pump manufacturer. The possibility exists that this operation might be phased out with time as the water infiltration control measures (i.e. poplar trees and clay cap) take effect. Seepage production is predicted to be reduced sufficiently that the seepage contribution will be negligible, or that seepage volume and contaminant loading will be reduced such that a natural treatment system can be installed to provide long-term passive water quality improvement.

The OMM costs of the ATP for treatment of the contaminated seepage and groundwater from the collection wells at the Tailings Area dams walls will be included in the Industrial Area Closure Plan. These efforts have not been duplicated in this evaluation. It is anticipated that the volume of leachate requiring treatment from the Tailings Area dams walls will be small relative to the rated capacity of the ATP (<10 percent). If the onsite ATP is phased out in the future, removal of any leachate from the collection system and transport to an offsite treatment facility will be required if it cannot be treated onsite using a natural treatment system.

5.2 Poplar Trees

In the short-term (first three years), maintenance requirements will include watering of planted/treed areas using the installed irrigation system as required to maintain plantation health, replacing plants as needed, checking for tree health, and addressing rodent activity (beaver and vole controls). Mowing between tree rows will reduce competition among the trees and expose rodents to predators. These activities will help to ensure that the freshly vegetated areas have a low mortality rate and that vegetation density increases to the required level.

5.3 Interceptor and Drainage Ditches and Soil Cap

Other maintenance efforts will include periodic maintenance of the engineered soil cap, stormwater interceptor ditches, and the surface water drainage ditches to repair any erosion damage and areas of vegetative stress.

5.4 Perimeter Fencing

The perimeter fence for the mine site is outside the Tailings Area and will be dealt with in the other Closure Plans.

6. Monitoring Program

A comprehensive monitoring plan will be required to determine the effectiveness of the implemented remediation measures.

The current site-wide monitoring program (i.e. surface water, groundwater, pumping system, ATP inlet and outlet) will be extended to monitor site conditions and the effectiveness of the site rehabilitation measures. This will include the existing monitoring wells, the surface water sampling stations and the operational sampling stations, as well as time domain reflectometry (TDR) measurements of the cover and cap elements. Provided that the monitoring confirms the effectiveness of the closure measures in reducing the flux of arsenic and heavy metals reaching the Moira River and Young's Creek, the frequency of the sampling may be gradually reduced.

Water level measurements will help determine whether the water table effectively drops at the Tailings Area dams walls as a result of the groundwater extraction measures as well as the reduction of infiltration. It is expected that groundwater extraction and treatment will probably not vary in the short term and that dissolved contaminant concentrations values will likely stay significant until the new hydrogeological regime is established. Data obtained from the surface water monitoring stations will demonstrate the effectiveness of the new engineered and vegetated cap.

Periodic monitoring is anticipated to be required during the following two phases:

- Phase 1: Post-Construction Performance Assessment – to assess the potential exposure pathways (seepage and groundwater) and whether or not these are significant
- Phase 2: Long-Term Monitoring and Maintenance (repairs to cover, cleaning of groundwater collection system, poplar tree care, etc.)

Monitoring programs that will likely be prescribed for the Tailings Area are summarized in Table 6.1.

The results of monitoring during closure activities should be documented in a Closure Report. During the post-closure period, annual reports should be prepared that document the results of monitoring activities for that year, discuss past trends in the data and forecast trends for the future.

TABLE 6.1
MONITORING PROGRAM

Type of Monitoring	Description	Duration	Frequency
Poplar Cap Performance	Visual inspection of vegetative cover, erosion problems, tension cracks, seeps, TDR measurements	Indefinitely following Tailings Area capping	Semi-annual for Years 0 to 3 Annual after Year 3
Water Quality	Sampling and analysis of surface water at key selected locations	During the ditch excavation and well drilling stage of the project	Weekly during excavation
Water Quality	Sampling and analysis of groundwater and surface water at key selected locations Sampling and analysis at seepage and groundwater collection wells	Indefinitely following Tailings Area capping	Semi-annual for Years 0 to 5 Annual after Year 5
Pumping and Conveyance	Visual inspections and pressure testing	Throughout the pumping period	Monthly (with alarms in place)
Biomonitoring	Vegetation tissue and invertebrate sampling, soil moisture monitoring, visual observations	Indefinitely following Tailings Area capping	Annually for Years 0 to 5 Once every five years for the next 20 years Once every 10 years thereafter
ATP Influent/ Effluent Quality	Sampling and analysis of influent/effluent from ATP	Refer to the Closure Plan for the Industrial Area	Refer to the Closure Plan for the Industrial Area

The various components associated with the monitoring program are described in detail below.

6.1 Poplar Cap Performance

During construction of the engineered soil cap, compaction testing will be undertaken to verify compliance with compaction standards described in the specifications. After construction is completed, the newly modified site will be monitored for erosion, slumping, and dam integrity.

Long-term monitoring of the physical stability of the vegetated cover will be required. Physical monitoring of the vegetated cap will include assessment of surface water erosion damage, vegetative stress, tension cracks at the crest of slopes, and seepage along the side slopes. Semi-annual physical stability monitoring is recommended for the first three years after the vegetative cover has been planted. When the vegetative cover has become well established, annual monitoring is recommended.

Checking for tree health and addressing rodent activity by implementing beaver and vole controls will help to ensure that the vegetated areas have a low mortality rate and that vegetation density increases to the required level. The long-term monitoring will be less frequent than the short-term monitoring. Plant growth monitoring will be used to determine seasonal trends and if plant replacement is required.

To determine the percolation control success of the poplar tree plantation, TDR probes will be installed to monitor soil moisture at various depths. Four nests of four TDR probes will be installed at 0.3-m, 0.6-m, 1.0-m, and 1.3-m depths.

6.2 Chemical Stability and Water Quality

An extensive program is in place to monitor surface water and groundwater quality at the Deloro site. The program includes the monitoring of the seepage at the Tailings Area dams walls. Two monitoring networks on the Moira River and Young's Creek provide information on surface water quality and a series of monitoring wells on the site property assess groundwater levels and quality.

Future chemical stability and water quality monitoring efforts will be focused on the monitoring of surface water and groundwater at selected locations to evaluate the effectiveness of the recommended alternative following implementation.

The existing monitoring wells in the Tailings Area will need to be decommissioned prior to the construction of the vegetated cap. New groundwater monitoring wells will need to be installed at selected locations to undertake post-remediation groundwater monitoring. Monitoring wells will be installed in the Tailings Area upgradient of the dams walls because water quality at the toe of the dams walls will be monitored by measuring the water quality of the wells during pumping cycles.

Semi-annual monitoring of surface water quality at the selected locations is recommended initially for the first five years following completion of the Tailings Area rehabilitation activities. Provided that the results do not indicate any adverse impacts on surface water quality, the monitoring frequency would be reduced to annually following the initial five years.

The surface water sampling locations associated with the Tailings Area will be selected as part of a site-wide monitoring program to evaluate the improvement in water quality in the Moira River and Young's Creek. The post-remediation surface water sampling locations are anticipated to be similar to the existing monitoring networks on the Moira River and Young's Creek. This will allow comparison of post-remediation water quality data with (historical) data currently being collected by OCWA.

Testing of groundwater from the seepage and groundwater collection wells (i.e. sample collection, analysis, recording, plotting), recording of flow rates, groundwater level monitoring, and alarm testing will be required to track changes in each of these components over time and to predict their impact on the ATP.

6.3 Seepage and Groundwater Collection, Pumping, and Conveyance System

The monitoring of the seepage and groundwater pumping operations to ensure that the required pumping rate and the pipe integrity are maintained will be required. Monitoring will include pressure testing that may be as frequent as weekly if no alarms are in place and could be monthly if alarms are in place and tested regularly.

6.4 Biomonitoring

Biomonitoring will be undertaken in areas where natural environmental restoration measures are planned including the area affected by the construction of the interceptor ditch and the revegetation of the Tailings Area cap. The biomonitoring program will be undertaken during the first growing season following the construction of each remediated area, and annually thereafter for a total of five years. Biomonitoring will then be conducted once every five years over a twenty year period, and then every ten years over the long-term period.

Qualified field personnel will evaluate the success of herbaceous vegetation (i.e. grasses, wildflowers etc.) seeding and woody plantings. Annual monitoring for five years is required to allow the establishment of the poplar trees and to ensure they are functioning to minimize infiltration. Soil moisture and plant health/condition will be monitored and any hybrid poplar trees that are determined to be inadequate or dead will be replaced. Native colonizing species of shrubs and trees that germinate and grow in these areas will also be documented.

To further support the goals and objectives of the Tailings Area Closure Plan, the monitoring program may include the collection of plants (leaves and/or stems) from the capped and covered areas during the growing season and prior to senescence. The concentration of arsenic and metals of concern in the plant tissues could be chemically determined. Trends could be identified and comparisons to benchmark, toxicological and site data could be conducted to ensure that the closure objectives of the Tailings Area are being met.

Wildlife use, including direct sightings or signs such as tracks, burrows, dens, nests, and scat in the Tailings Area should be documented and recorded on a site map, as one of the site-wide closure objectives is to increase the quantity and quality of wildlife habitat and wildlife diversity. Wildlife observations could be documented by qualified field personnel while undertaking the other investigations and thus, would be completed with the same frequency and over the same period of time.

6.5 Site Management

It is anticipated that the following site management actions will be implemented or maintained:

- Fencing exists on the perimeter of the Deloro Mine Site and access will be restricted to authorized personnel.
- Signage exists on the perimeter fence as well as at the north and south approaches along the Moira River.
- The MOE will retain ownership and control of the site for the foreseeable future.
- Site conditions will be registered on title at the conclusion of the cleanup coincident with the issuance of a Record of Site Condition (RSC).

7. Malfunctions, Accidents, and Mitigation Measures

During the implementation and operation of the rehabilitative measures at the site, there is a potential that malfunctions (i.e. in design, construction, or commissioning) or accidents (e.g. due to acts of nature) could occur. These malfunctions and accidents can adversely affect remediation activities, and OMM of the site, resulting in delays or costly mitigation measures. These events must be considered and mitigation measures must be developed to ensure environmental impacts are minimal and acceptable.

Table 7.1 identifies mitigation measures for potential malfunctions and accidents that have a reasonable probability of occurring at the site during three time frames:

- Short-term: Preparation activities
- Mid-term: Remediation activities
- Long-term: OMM activities

TABLE 7.1
MALFUNCTIONS, ACCIDENTS AND MITIGATION MEASURES IN THE TAILINGS AREA

Malfunction (M) or Accident (A)	Mitigation Measures
Short-term: Preparation Activities	
M/A – Perpetual disruptive forces (MNDM, 1995)	The recommended alternative for the rehabilitation of the Tailings Area incorporates measures to mitigate perpetual disruptive forces.
A – Spill of contaminated soil, ATP related chemicals, fuel for construction equipment/vehicles	Construction contractors and other site personnel should be trained to respond to spills. Spill would be isolated and transferred to waste consolidation area or to an acceptable waste receiver if spill occurs offsite.
Mid-term: Remediation Activities	
M/A – Perpetual disruptive forces (MNDM, 1995)	The recommended alternative for the rehabilitation of the Tailings Area incorporates measures to mitigate perpetual disruptive forces.
A – Spill of contaminated soil, ATP related chemicals, fuel for construction equipment/vehicles	Construction contractors and other site personnel should be trained to respond to spills. Spill would be isolated and transferred to waste consolidation area or to an acceptable waste receiver if spill occurs offsite.
M/A – During cap/cover placement soils and vegetation could wash away	Straw blown onto sloped areas that are freshly planted, planting with annual rye or wheat will help stabilize the soil. If soils are washed away, then replace the soil and replant.
Long-term: Operation, Maintenance, and Monitoring Activities	
M/A – Perpetual disruptive forces (MNDM, 1995)	The conceptual design of the engineered soil cover, including the interceptor ditch, incorporates measures to mitigate perpetual disruptive forces. Further refinements will be addressed during detailed design.
A – After planting, soils and vegetation could be washed away	Replace soils and replant.

TABLE 7.1
MALFUNCTIONS, ACCIDENTS AND MITIGATION MEASURES IN THE TAILINGS AREA

Malfunction (M) or Accident (A)	Mitigation Measures
M – Diversion ditch fills with sediment and debris or requires repairs	Periodic monitoring program will identify need for cleaning or repairing diversion/drainage ditches. The site OMM manual will provide Diversion/ Drainage Ditches Cleaning and Repair procedures and protocols.
M – Poplar tree mortality due to soil conditions, contaminants, rodents, etc.	Install raptor perches to encourage hawks and owls to prey on rodents. Monitor routinely the health of the trees. Mulch trees, keep grass mowed to reduce potential for rodent damage. If mortality occurs, determine cause of mortality (soil conditions, contaminants, rodents) and rectify then replace trees.
M – Seepage and groundwater transfer pump failure	Use standby pump, routine monitoring of pump performance.
M – Seepage and groundwater transfer pump capacity insufficient	Purchase appropriate pump and replace original pump.
M – Piping failure	Install auto shutoff that is triggered if back pressure is too low – routinely monitor the pipe integrity.
M – Piping frozen	Shut down pump and thaw line – check heat tracing integrity – routinely monitor that the collected water is flowing.
M – Irrigation system not functioning	Troubleshoot and repair and restart or, if problem cannot be easily remedied, use a watering truck.
M – Electrical short-circuiting in pump control panel	Troubleshoot and repair. If due to rain/moisture, ensure waterproof features are in place.
M – Cover failure due to flooding	Since the majority of the cover is about 5 m above the floodplain of the 100-year flood, severe flooding that could potentially compromise the integrity of the cover and lead to the release of some of the contained tailings is considered remote.
A – Seismic occurrences	Design long-term structures at the Deloro site to the appropriate Seismic Zone . The probability of an earthquake of sufficient magnitude to breach the cover of the Tailings Area is very small given the stability of the region (Zone 1, low risk of earthquake). Any damaged areas during such an event would be identified and rectified using defined maintenance procedures.

Notes: Perpetual disruptive forces are defined in MNDM (1995) to include wind erosion; water erosion due to flooding, sheeting, rilling, and gulleying; sedimentation and debris accumulation; annual ice accumulation; seasonal frost penetration; soil restructuring; and physical and chemical weathering. Biological activities include root penetration, burrowing, intrusion, and actions by animals and man.

8. Expected Post-Closure Conditions and Uses

This section provides an assessment and description of the expected conditions and uses following closure activities.

8.1 Land Use

The final intended use of the site will be specified as a component of the federal EA. It is anticipated that access to the site will continue to be restricted and the fence that currently surrounds the site will be maintained for the foreseeable future.

8.2 Topography

In general, the topography in the Tailings Area will be heavily dependent on:

- The final grade of the land, suitable for stormwater runoff yet minimizing stormwater erosion
- The thickness of the engineered cover applied to the area

It is anticipated that the engineered cover will rise to a maximum elevation of about 197.25 masl at the west end of the Tailings Area, approximately 1.75 m higher than the current maximum grade in this area. The minimum elevation is expected to be about 193.75 masl, which is approximately 3.5 m higher than the minimum grade in the area. The added fill material is required to prevent ponding on the Tailings Area surface.

Public visual impacts associated with the Tailings Area are anticipated to be minimal, as the top elevation of the area (197.25 masl) will be 5.75 m to 9.25 m lower than the ground elevation in the Village of Deloro. Tree cover between the Village and the Tailings Area as well as the tree cover on the Tailings Area will reduce visual impacts to Deloro residents.

8.3 Water Resources

It is anticipated that the implementation of the recommended rehabilitation alternative for the Tailings Area will result in a marked improvement in water quality in the Moira River and Young's Creek.

8.4 Plant and Animal Life

As noted in Section 2.1.2, the post-closure risks to ecological receptors from the draft SLERA are not conclusive given information that is currently available. Additional site information is being collected and further risk evaluation is underway.

9. Approval Requirements

The primary site-wide regulatory approvals that must be applied for and issued by the appropriate government agencies are outlined in this section of the Closure Plan.

9.1 Site-Specific Risk Assessment

SSRA is the remedial approach selected from the options available in the Guideline for Use at Contaminated Sites in Ontario (1997). There are a number of steps to approval of an SSRA to ensure that public health and the environment are protected. First, an SSRA is reviewed by an independent third party peer reviewer who is qualified and experienced in conducting SSRAs. Once the peer reviewer's comments have been incorporated, the SSRA is submitted to the Standards Development Branch (SDB) of the MOE, which undertakes a review of both technical and policy issues. Other prerequisites for acceptance of the SSRA include community-based public communication and dialogue with the municipality regarding the SSRA. Once these steps have been completed, the cleanup can proceed.

As confirmation that the actual cleanup is completed according to the SSRA, a Record of Site Condition (RSC) will be prepared and filed to document the cleanup. The RSC is completed jointly by the proponent, MOE, as well as the consultant overseeing the cleanup. The SSRA is a Level 2 Risk Management involving the use of engineered controls (i.e. engineered covers, groundwater pumping/treatment systems). A Level 2 Risk Management requires Registration on Title for the property to document the conditions of the land in the public domain. Registration on Title will be accomplished through filing a Certificate of Prohibition.

As a result of the different land ownership between the Deloro Mine Site and the Young's Creek Area south of Highway 7, a separate SSRA report has been prepared for each of these two land parcels (see Section 2.1) following the process described in this section.

The current process for completing SSRAs, outlined above, was developed in 1997 and has been in place since that time. New legislation has been passed that is anticipated to modify this process once the enabling regulations are finalized. The new legislation, the *Brownfield Law Statutes Amendment Act*, received Royal Assent on November 21, 2001 and the public comment period for the regulations ended on April 29, 2003. Final regulations, which are expected to be released through 2003, may change the SSRA process from a guideline-driven to a regulatory-driven process. The draft regulations do not suggest significant change in the technical approach to SSRAs, but they do indicate some changes in the administrative aspects. The Deloro Mine Site SSRA will be adapted, if needed, to meet the new regulatory requirements.

9.2 MOE Authorizations

Under the *Environmental Protection Act* (EPA) and the *Ontario Water Resources Act* (OWRA), approval is required from the MOE for processes that emit to the environment or for waste management activities. The primary means of approval is through issuance of a Certificate

of Approval (C of A) for air or water emissions or a Provisional Certificate of Approval (PC of A) for waste related activities. A Permit to Take Water (PTTW) is required for water extraction above 50,000 L/day. Generator Registration is required for ongoing waste generation, such as the ferric arsenate sludge, which is generated by the onsite ATP.

A number of MOE authorizations already exist at the Deloro Mine Site as a result of environmental mitigation actions implemented to date. This includes extraction and pumping of impacted groundwater, treatment of water in the ATP, discharge of the treated effluent and storage/dewatering of sludge from the treatment process. A listing of the MOE authorizations currently in place at the Deloro Mine Site is provided in Table 9.1.

The Closure Plans will result in changes to the currently authorized systems, plus the addition of new systems. Changes to the current systems will require modifications to the existing MOE authorizations, most likely through an amendment (i.e. C of A Amendment). New systems will require new authorizations to be developed.

Certificate of Approval – Sewage

Amendment to the existing C of A for the ATP, sludge storage lagoon, pumping stations, and forcemains may be required to accommodate modifications to these systems as a result of the Closure Plans.

Certificate of Approval – Air

There is no anticipated requirement for modification of the existing C of As or to obtain new C of As as a result of the Closure Plans.

Permit to Take Water

The existing PTTW for the Tuttle Shaft pumping station will require amendment to account for installation of a permanent forcemain and the increase in pumping to year-round operation. Other PTTWs for the other pumping stations may also require some modifications.

In the Industrial Area, a new PTTW will be required to authorize the construction and operation of a groundwater interceptor system at the western property line. Similarly, a new PTTW will be needed in the Tailings Area for groundwater pumping from wells located in the vicinity of the tailings dams walls.

Provisional Certificate of Approval – Waste Disposal

The site cleanup is following the SSRA process (outlined above) where existing residuals and by-products will be managed onsite through a Level 2 Risk Management involving isolation and containment. Although the legacy materials being managed have been in place for several decades and are not the result of ongoing waste production and many of the materials are the result of mining activities (i.e. mill tailings from a mine) that are exempt from Ontario's Waste Management Regulation, the MOE has committed to seeking a PC of A for the proposed waste management facilities under Part V of the EPA. The development of Closure Plans for the Deloro site has drawn on landfill design standards, as well as mine closure and other guidelines, as general guidance and best management practices to ensure that the site is engineered and maintained to be safe and secure for hundreds of years.

TABLE 9.1
EXISTING MOE AUTHORIZATIONS FOR THE DELORO MINE SITE

Authorization	Type	Number	Date	Description
Certificate of Approval	Sewage	4-036-82-006	28 Jul 1982	Collection/storage/ treatment system
Certificate of Approval	Air	8-4042-82-006	8 Sep 1982	Lime silo venting and fume hood exhaust
Certificate of Approval	Sewage	4-053-83-006	18 Jul 1983	Pumping station and forcemain
Provisional Certificate of Approval	Waste Disposal Site	A362106	6 Sep 1983	Temporary storage processed sludge
Permit	Permit to Take Water	85-P-4006	26 Apr 1985	Tuttle shaft and pumping station #5
Certificate of Approval	Sewage	4-041-85-006	25 Jul 1985	Sludge drying lagoon
Permit	Permit to Take Water	85-P-4038	16 Aug 1985	Moira River
Certificate of Approval	Sewage	4-067-85-006	16 Sep 1985	Manhole rehabilitation
Certificate of Approval	Air	8-4069-86-006	17 Nov 1986	Plant exhaust system
Certificate of Approval	Sewage	4-116-86-876	8 Jul 1987	Tuttle shaft pump and forcemain
Certificate of Approval	Sewage	4-0155-87-006	20 Nov 1987	Sludge testing lagoon
Certificate of Approval	Air	8-4120-88-006	12 Dec 1988	Lab equipment exhaust
Generator Registration	Waste Streams	ONO199886	23 Jan 1989	Arsenic compounds and oils
Certificate of Approval	Air	8-4128-89-006	4 Dec 1989	Lab fume hood exhaust
Permit Amendment	Permit to Take Water	83-P-4010	6 Jun 1990	Pumping station #3
Permit Amendment	Permit to Take Water	82-P-4035	6 Jun 1990	Pumping stations #1, #2, and #4
Certificate of Approval Amendment	Industrial Sewage	4-041-85-006	27 Nov 1992	Sludge storage lagoon expansion
Permit Amendment	Permit to Take Water	85-P-4006	21 Feb 1996	Tuttle shaft and pumping station #5
Certificate of Approval Amendment	Industrial Sewage Works	4-036-82-006	20 Apr 2000	Decontamination facilities
Generator Re-registration (HWIN)	Waste Streams	ONO199886	Jan 2002	Ferric arsenate sludge
Provisional Certificate of Approval	Waste Disposal Site	2668-5DHJEW	30 Aug 2002	Temporary storage contaminated soil
Provisional Certificate of Approval Amendment	Waste Disposal Site	2668-5DHJEW	12 Nov 2002	Contingency plan

The Deloro Mine Site Cleanup Project is being carried out under an exemption to the provincial *Environment Assessment Act* (EAA). Ontario Regulation 577/98 (O.Reg 577/98) exempts the Deloro Mine Site Cleanup Project from a mandatory hearing under Part V of the EPA (Sections 30 and 32).

9.3 Conservation Authority

Through the Fill, Construction and Alteration to Waterways Regulation, which is administered in support of Section 28 of the Conservation Authorities Act of Ontario, the Conservation Authority regulates and may prohibit work taking place within valley, river, stream and watercourse corridors as well as along lake waterfronts.

Fill regulations allow the Authority to prohibit or regulate the placing, excavation, grading or dumping of fill of any kind for projects such as pools, ponds, roads, and driveways. These regulations are applied when, in the opinion of the Authority, the control of flooding, pollution, or the conservation of land within its jurisdiction may be affected by the placing or dumping of fill.

Construction regulations allow the Conservation Authority to regulate construction in or on a wetland or floodplain, or in any area susceptible to flooding during a regional storm. In this regulation, construction refers to new buildings, additions to existing buildings, stormwater outfalls, culverts, and bridges.

The alteration to waterways regulations allow the Conservation Authority to prohibit or regulate the straightening, changing, diverting, or interfering with the existing channel of a river, creek, stream, or watercourse.

Based on the remedial works that are proposed along the west bank of the Moira River (reconstruction) as well as within Young's Creek (sediment and soil removal and wetland rehabilitation), it is anticipated that a permit "To Construct, Place Fill, or Alter a Waterway" will be required from the Moira River Conservation Authority (MRCA) c/o Quinte Conservation (QC).

9.4 Ministry of Natural Resources

Of note within the Deloro Mine Site property and in the Young's Creek Offsite Area is a Provincially Significant Wetland (PSW), the Deloro Wetland Complex. The Deloro Wetland Complex, including the area along Young's Creek south of Highway 7, was evaluated during the summer of 2000 using the 3rd Edition of the wetland evaluation manual (Snider's Ecological Services, 2000). The wetland received a total score of 688 and was evaluated as a Class 2 PSW.

The management of Ontario wetlands and lands adjacent to them is implemented through the *Wetlands Policy Statement,* which falls under the jurisdiction of the *Planning Act*. The MNR and the Minister of Municipal Affairs jointly issued the *Wetlands Policy Statement*. The policy requires that all planning jurisdictions protect PSWs such that development is not permitted in PSWs that are located within the Great Lakes—St. Lawrence Region. Development and alteration may be permitted on lands adjacent to PSWs only if it does not result in:

- Loss of wetland function

- Subsequent demand for future development that will negatively impact existing wetland functions
- Conflict with existing site-specific management practices
- Loss of wetland area

An Environmental Impact Study (EIS) would have to be prepared in order to permit development on these adjacent lands.

Consultation is required with the MNR, and possibly the Minister of Municipal Affairs, to determine whether any of the project components, such as construction of the Young's Creek Area onsite containment cell and dredging, constitutes wetland "development" and whether the project can be permitted. Also, the MNR would need to determine whether an EIS would need to be completed.

The MNR is also responsible for issuing Work Permits under the authority and provisions of several different Provincial Acts. If the project is allowed to proceed, the Provincial Acts that apply to this project would have to be determined in consultation with the MNR. The following Provincial Acts and their regulations are considered in the application for a Work Permit.

Forest Fire Prevention Act: The MNR administers this Act. A Work Permit is required to authorize any work on Crown land and to ensure that adequate forest fire precautions and equipment are in place.

Lakes and Rivers Improvement Act: The purpose of this Act is to manage the use of the lakes and rivers in Ontario and to regulate improvements to them. The Act provides for the preservation of public rights in or over water; protection of the interests of riparian owners; management of fish, wildlife, and other natural resources dependent on such waters; preservation of natural amenities; and suitability of the location and nature of improvements. The *Lakes and Rivers Improvement Act* gives the MNR the mandate to manage water-related activities, particularly in the areas outside the jurisdiction of Conservation Authorities.

Public Lands Act: This Act, which is administered by the MNR, authorizes the construction of roads on Crown lands, sets out Crown cost-sharing of company roads, limitations on liability and tenure for private forest roads and camp areas, and defines the applicability of the *Highway Traffic Act* on access roads.

As part of the application for a Work Permit, each project proponent must complete and apply for "Parts" of the permit. The determination of which Parts (i.e. A through F) are applicable to the project is conducted in consultation with the MNR. The Parts that must be taken into consideration when applying for a Work Permit are briefly described below:

- *Part A*: Fire Prevention and Suppression/Logging Activities
- *Part B*: Mineral Exploration Activities
- *Part C*: Building Construction
- *Part D*: Application to do Work on Shore Lands
- *Part E*: Roads, Trails, or Water Crossings
- *Part F*: Works Within a Waterbody

Based on the work proposed at the Deloro Mine Site, a Work Permit will be required from the MNR. Several Parts to the application will have to be completed possibly including, but

not limited to, Parts A, D, and F. It is anticipated that the MNR will include conditions pertaining to work in the PSW with those issued as part of the Work Permit.

9.5 Department of Fisheries and Oceans/ Canadian Coast Guard

9.5.1 Navigable Waters Protection Act (NWPA)

The purpose of the NWPA is to protect the public right to marine navigation and to ensure unobstructed passage of vessels in Canadian waters. Any construction, modification or repair of a work that will interfere with navigable waterways must be approved or concurrence provided by the DFO and is administered by the Canadian Coast Guard (CCG). The removal of obstructions to navigation and the provision and maintenance of lights and markers required for safe navigation is also covered under this Act. Although the section of the Moira River that passes through the site has limited use for boating, many parts of the Moira River are navigable and the CCG should be consulted on the final cleanup plan for the site.

9.5.2 Fisheries Act

The federal Minister of Fisheries and Oceans has the legislative responsibility for the administration and enforcement of the federal *Fisheries Act*. The *Fisheries Act* protects and conserves fish and fish habitats and has the power to deal with damage to fish habitat, destruction of fish, obstruction of fish passage, necessary flow requirements for fish, and the control of deleterious substances. Section 35(1) of the federal *Fisheries Act* states that "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat" (HADD). Any proposed works and activities that are likely to alter or damage fish habitat must be reviewed and authorized by the DFO. The Conservation Authorities have agreements with DFO in the evaluation and processing of applications and therefore would also have to be consulted.

It is important to note that DFO has also developed a Policy for the Management of Fish Habitat that includes a No Net Loss guiding principle. This principle is applied to any proposed development that would result in a loss of productive fish habitat. The regulatory agency would review the measures to determine if they meet not only the No Net Loss of fish habitat, but also the DFO's long-term policy objective of achieving an overall net gain of the productive capacity of fish habitats. Therefore, works requiring an authorization from the DFO typically includes a Fisheries Compensation Plan that describes the measures taken to realize an overall net gain in the productive capacity of fish habitats as a result of the project.

A section of the west bank of the Moira River in the Industrial Area will be reconstructed, and a significant amount of work is proposed within Young's Creek including the excavation of contaminated sediment/soil and wetland rehabilitation. As this will affect fish habitat, a Fisheries Act authorization will be required and a Fisheries Compensation Plan may have to be prepared. In addition, application for a blasting permit may be required to address "destruction of fish by any other means" (under the *Fisheries Act*), since a portion of the onsite containment cell will be located in Young's Creek.

9.6 Environmental Assessment and CNSC Licensing

The *Nuclear Safety and Control Act* (NSCA) mandates the CNSC to regulate all aspects of the nuclear industry in Canada, including the management and isolation of nuclear wastes. Paragraph 26 of the NSCA states that:

> "Subject to the regulations, no person shall, except in accordance with a licence,…possess…manage, store or dispose of a nuclear substance. . ."

It is with respect to this paragraph that the MOE seeks to obtain a licence to manage and store, at various locations on the Deloro Mine Site, the radioactive wastes present on the site. Conceptual waste isolation scenarios are presented in Section 3.4 of this and other Closure Plans for radioactive (and non-radioactive) materials.

CNSC's authorization of the project would be provided through the issuance of a Waste Nuclear Substance Licence (WNSL) for the possession, management and storage of nuclear substances, pursuant to subsection 24(2) of the NSCA.

As previously noted, because nuclear waste management and storage is a physical activity listed in the "Inclusion List Regulation" of the CEAA, the proposed project is subject to the federal Environmental Assessment (EA) process. Therefore, the licensing and the federal EA processes are closely linked, as explained below.

The screening level EA process being followed for this project is outlined in Section 2.3. At the completion of the EA study, the proponent must summarize the process and the results of the EA into a report that is submitted to the RA for its review. Once the RA is satisfied that the EA has met the initial scope, the report is then submitted to the members of the CNSC for its approval. A hearing in which the proponent presents the project and where the public is invited to voice its concerns or support may be required.

Following the approval of the results of the EA by the CNSC, an application for a WNSL must be formally submitted by the proponent in accordance with the General Nuclear Safety and Control Regulations and Nuclear Substance and Radiation Devices Regulations of the NSCA. A WNSL is applicable, as opposed to a Class Ib Nuclear Facility Licence, because mainly chemical wastes are being managed with the presence of some radioactive materials.

As part of the application for a WNSL, safety analyses must be conducted to ensure radiation exposures to both workers and the public are acceptable during normal and abnormal conditions at the site.

Some applicable portions of the General Nuclear Safety and Control Regulations which must be addressed in the application are as follows:

> 3 (1) (*e*) the proposed measures to ensure compliance with the *Radiation Protection Regulations* and the *Nuclear Security Regulations*;
> (*f*) any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*;
> (*g*) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;
> (*h*) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment

> or prescribed information;
> (*i*) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;
> (*j*) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;

Some applicable sections of the Nuclear Substance and Radiation Devices Regulations are as follows:

> **3.** (1) An application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*:
> (*a*) the methods, procedures and equipment that will be used to carry on the activity to be licensed;
> (*b*) the methods, procedures and equipment that will be used while carrying on the activity to be licensed, or during and following an accident, to
> (i) monitor the release of any radioactive nuclear substance from the site of the activity to be licensed,
> (ii) detect the presence of and record the radiation dose rate and quantity in becquerels of radioactive nuclear substances at the site of the activity to be licensed,
> (iii) limit the spread of radioactive contamination within and from the site of the activity to be licensed, and
> (iv) decontaminate any person, site or equipment contaminated as a result of the activity to be licensed;
> (*c*) a description of the circumstances in which the decontamination referred to in subparagraph (*b*)(iv) will be carried out;

Following submission of the application and any clarifications and/or additional materials required by CNSC staff, a draft licence is then prepared by CNSC staff, discussed with the proponent and ultimately presented to the members of the CNSC for approval. A hearing in which the proponent presents its application and where the public is invited to voice its concerns or support may be required. Upon acceptance, a WNSL is issued and remedial work can begin under the conditions of the Licence.

9.7 Mining Act

The regulatory considerations relevant to the Deloro project were examined early in the project and have been refined as the project has progressed. The document entitled *Deloro Mine Rehabilitation Project - Development of Closure Criteria, Final Report* (CG&S, October 1998) summarized the application of the *Mining Act* to the Deloro project. Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act*, the Closure Plans have been developed to satisfy, in general, the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). MNDM has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

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APPENDIX A

SUMMARY OF MAJOR COST ITEMS FOR TAILINGS AREA CLOSURE PLAN

APPENDIX A

Summary of Major Cost Items for Tailings Area Closure Plan

Opinions of Probable Construction Cost

In providing opinions of probable cost, MOE understands that CH2M HILL has no control over the cost or availability of labour, equipment or materials, or over market conditions or the potential Contractor's method of pricing. CH2M HILL makes no warranty, express or implied, that the bids or the negotiated cost of the Work will not vary from the opinion of probable construction cost.

CH2M HILL has made efforts to acquire area specific rates for materials, labour, and equipment whenever possible. The suitability of said materials to the intended purposes were not verified and will need to be determined prior to any construction activities. Where a local source or supplier could not be identified, industry budgetary tools such as the R.S. Means Company Inc. costing guide were used to assign a typical value. Appropriate regional coefficients were applied where necessary to adjust the typical costs to address regional conditions.

Each specific area of interest has been examined as an independent project. Any possible synergies associated with co-execution of various areas were ignored. Prices provided include the federal Goods and Services Tax (GST).

Volumes and areas were determined using existing available information. No additional investigations were performed to confirm or refute the estimates. Some estimates such as potential water volumes were based on engineering experience from other similar projects. Probable construction costs were based on typical weather conditions and may require adjustments due to extreme conditions.

Certain construction costs such as overhead, insurance, and various construction bonds will vary based on the potential Contractor. Financial strength, experience, and previous history all play a role in determining the rates that will be applied to a particular Contractor. These sums were determined as a percentage of the total costs based on industry averages.

Several of the site remediation options involved additional pumping to the arsenic treatment plant located in the Industrial Area. The application of a varied number of options over the four main areas will result in increases and decreases of the total treated water volume. At this conceptual stage it is difficult to determine whether there will be a net increase or decrease to the volume of water to be treated. Therefore, the operation and maintenance of the arsenic treatment plant has only been considered in the Industrial Area Closure Plan. Actual operation and maintenance costs over the last decade were used to develop a weighted-average and one standard deviation was added to this value in an effort to create a conservative estimate. Wastewater treatment considerations for all other areas were limited to collection and transmission to the equalization pond (i.e. equalization/storage basin).

Finally, a 15 percent contingency was added to the final capital cost (before taxes, overhead, insurance, and bonds) and a 5 percent contingency was added to the final OMM costs (before taxes).

The net present value costs presented in the following cost breakdown are the sum of the capital cost and the net present value of the OMM costs. The annual OMM costs have been transformed to a net present value assuming an effective interest rate of 5 percent and a planning horizon of 20 years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs will be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

Cost opinions were developed based on information available at the time this report was prepared and are expected to have an accuracy on the order of +/- 25 percent. Use of this information for project budgeting purposes should include a factor for escalation if the contract will not proceed in the same calendar year.

Appendix A
Breakdown of Capital Costs of Work Packages and Operation, Maintenance, and Monitoring Costs

Work Package Identification No. and Description	Cost	Insurance	Overhead	Performance Bond	Labour and Material Bond	Remote Area Cost	Final Costs*
TA-WP#1: Site Preparation							
Temporary Roads	$36,792	$596	$1,435	$552	$552	$368	$40,300
Set-up	$44,347	$718	$1,730	$665	$665	$443	$48,600
Washpad	$16,811	$272	$656	$252	$252	$168	$18,400
Mobile Washer	$28,082	$455	$1,095	$421	$421	$281	$30,800
Surface Water Control	$54,740	$887	$2,135	$821	$821	$547	$60,000
Clearing and Grubbing	$78,005	$1,264	$3,042	$1,170	$1,170	$780	$85,400
Total	**$258,776**	**$4,192**	**$10,092**	**$3,882**	**$3,882**	**$2,588**	**$283,500**
TA-WP#2: Placement of Rip Rap and Geotextile							
Geotextile (over limestone cover and face of dams walls)	$280,105	$4,538	$10,924	$4,202	$4,202	$2,801	$306,800
Rip Rap at Toe of Dams	$6,240	$101	$243	$94	$94	$62	$6,800
Total	**$286,345**	**$4,639**	**$11,167**	**$4,295**	**$4,295**	**$2,863**	**$313,600**
TA-WP#3a: Installation of Engineered Cap, Ditches, and Grass Planting							
Cap Installation	$5,316,896	$86,134	$207,359	$79,753	$79,753	$53,169	$5,823,100
Interceptor Ditch	$385,180	$6,240	$15,022	$5,778	$5,778	$3,852	$421,800
Surface Water Quality Testing	$7,328	$119	$286	$110	$110	$73	$8,000
Final Grading (includes drainage ditches)	$111,806	$1,811	$4,360	$1,677	$1,677	$1,118	$122,500
Grass Planting	$65,907	$1,068	$2,570	$989	$989	$659	$72,200
TA-WP#3b: Installation of Poplar Plantation and Irrigation System							
Poplar Tree Planting	$70,050	$1,135	$2,732	$1,051	$1,051	$700	$76,700
Irrigation System	$155,037	$2,512	$6,046	$2,326	$2,326	$1,550	$169,800
Total	**$6,112,204**	**$99,018**	**$238,376**	**$91,683**	**$91,683**	**$61,122**	**$6,694,100**
TA-WP#4: Tailings Seepage and Groundwater Pumping and Piping System							
Seepage and Groundwater Collection Wells, Pumps, and Power Supply	$75,979	$1,231	$2,963	$1,140	$1,140	$760	$83,000
Overland Piping to Equalization Pond (includes heated enclosures)	$121,190	$1,963	$4,726	$1,818	$1,818	$1,212	$133,000
Total	**$197,170**	**$3,194**	**$7,690**	**$2,958**	**$2,958**	**$1,972**	**$216,000**
Total Capital Costs	**$6,854,495**	**$111,043**	**$267,325**	**$102,817**	**$102,817**	**$68,545**	**$7,507,200**
Operation, Maintenance, and Monitoring (Net Present Value, 20 year investment at 5%)							
Monitoring program: surface water, groundwater physical stability and biomonitoring (with 5% contingency)	$266,169 (14,132)**	NA	$10,381	NA	NA	$2,662	$279,000
Maintenance program: cap and ditches and operations and maintenance of seepage/groundwater collection system, including pump replacement (with 5% contingency)	$240,992 (18,417)**	NA	$9,399	NA	NA	$2,410	$252,800
Poplar monitoring and maintenance, including irrigation (with 5% contingency)	$725,852 ($55,471)**	NA	$28,308	NA	NA	$7,259	$761,400
Total OMM Costs	**$1,233,013**	**NA**	**$48,088**	**NA**	**NA**	**$12,330**	**$1,293,200**
Grand Total	**$8,087,500**	**$111,000**	**$315,400**	**$102,800**	**$102,800**	**$80,900**	**$8,800,400**

All capital costs include GST and a 15 percent contingency (before taxes, overhead, insurance, and bonds).
All OMM costs include GST and a 5 percent contingency (before taxes).
*Rounded to nearest $1,000. All costs have been developed using 2004 pricing and do not include an escalation factor.
**Annual (Weighted) OMM Costs (before overhead and remote area costs).